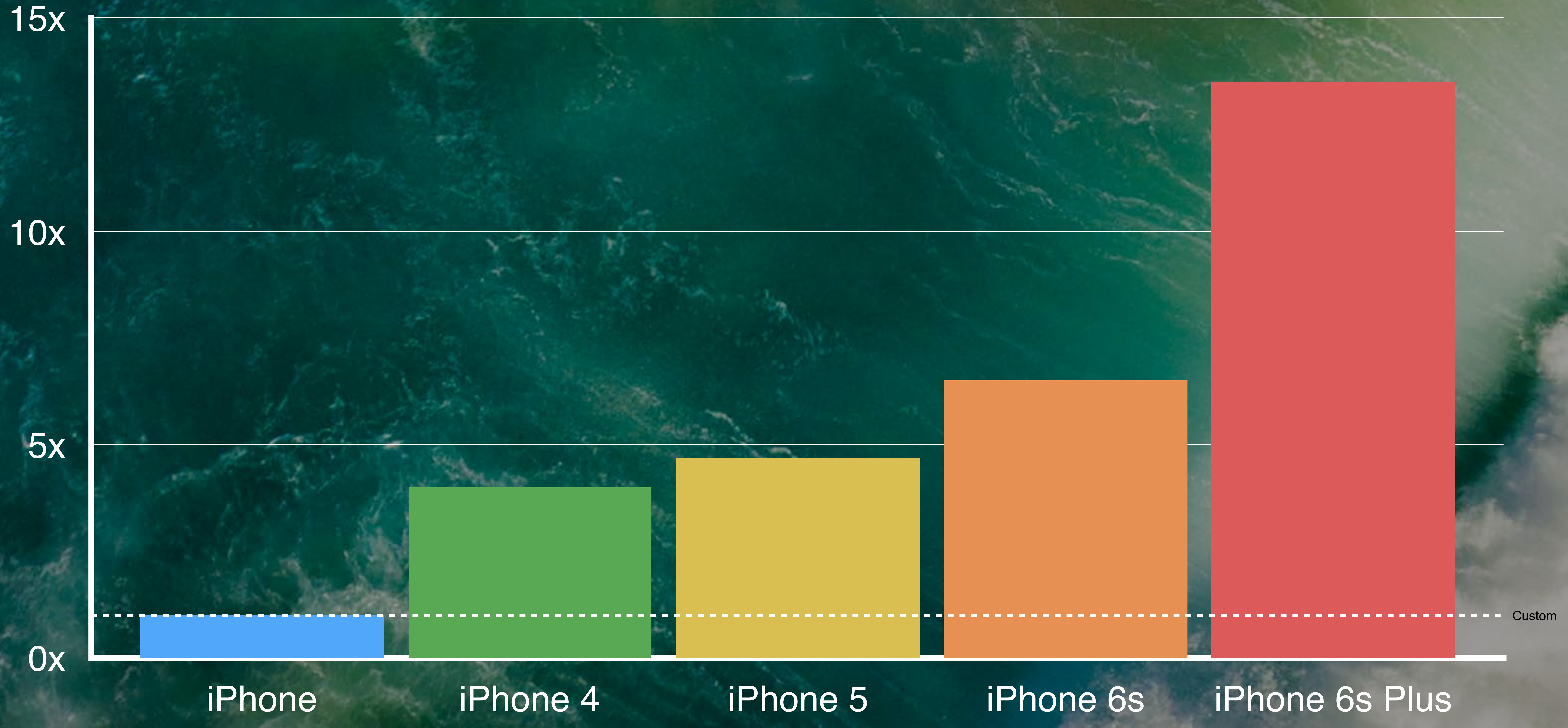
Optimizing I/O for Performance and Battery Life

Session 719

Kushal Dalmia Kernel Engineer
Terry Long Performance Engineer

iPhone Wallpaper Sizes

iPhone Wallpaper Sizes



VANCE JOY
'dream your life away'
spg
AMERICAN SNIPER
IMAGINE DRAGONS
SMOKE + MIRRORS
AZEALIA BANKS
BROKE WITH EXPENSIVE TASTE
STILL The KING
CELEBRATING THE MUSIC OF
Bob Wills and his Texas Playboys
A PRODUCT OF ASLEEP AT THE WHEEL
ALABAMA SHAKES
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FROM ACADEMY-AWARD® NOMINATED DIRECTOR

System Resources

System Resources

CPU

System Resources

CPU

Memory

System Resources

CPU

Memory

I/O

System Resources

CPU

Memory

I/O

System Resources

I/O

System Resources

Input/Output

I/O

System Resources

Input/Output

- Local Storage

I/O

System Resources

I/O

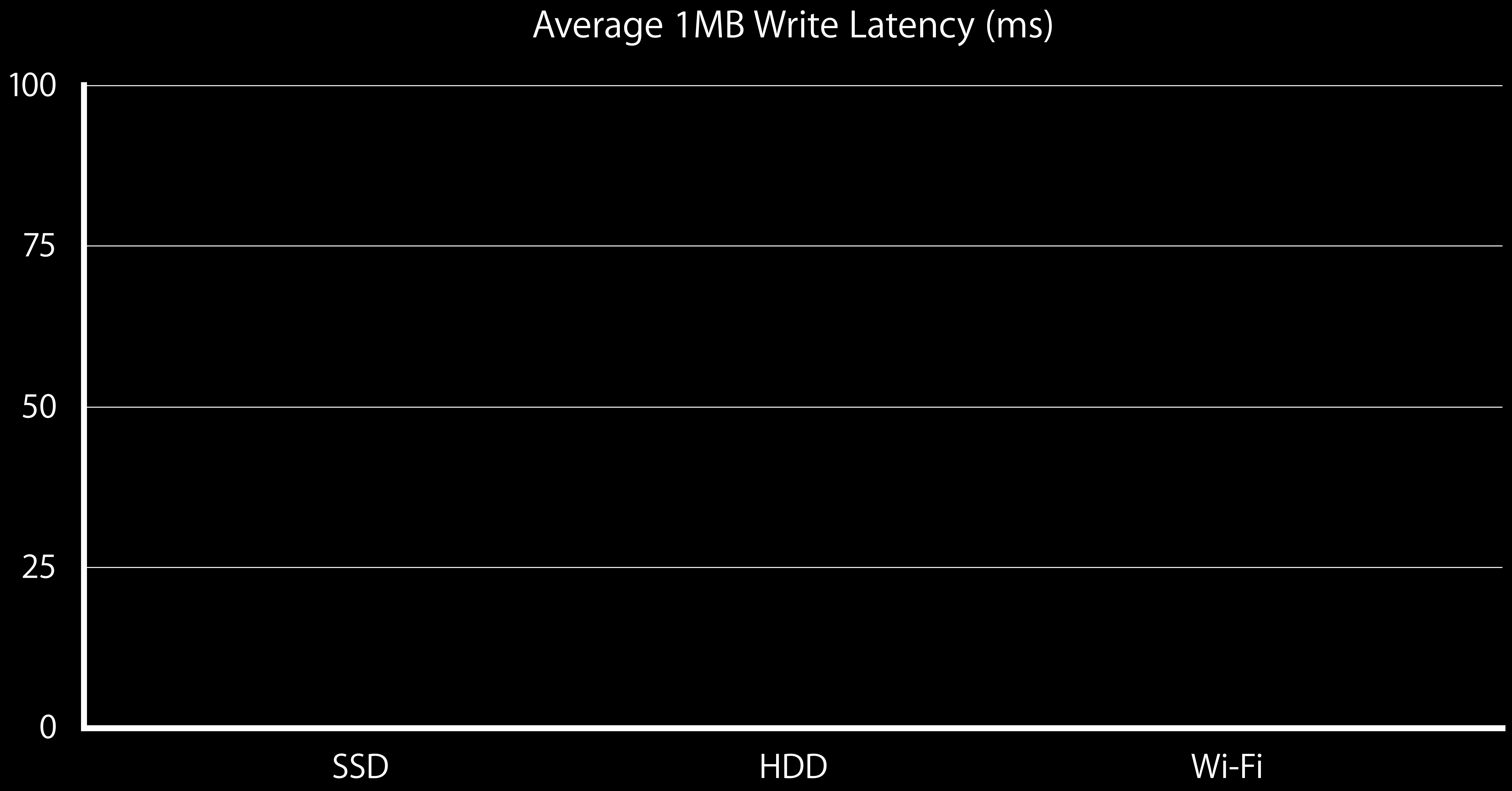
Input/Output

- Local Storage
- Network

I/O Technology Variation

Performance numbers are approximate and not representative of any specific product.

I/O Technology Variation



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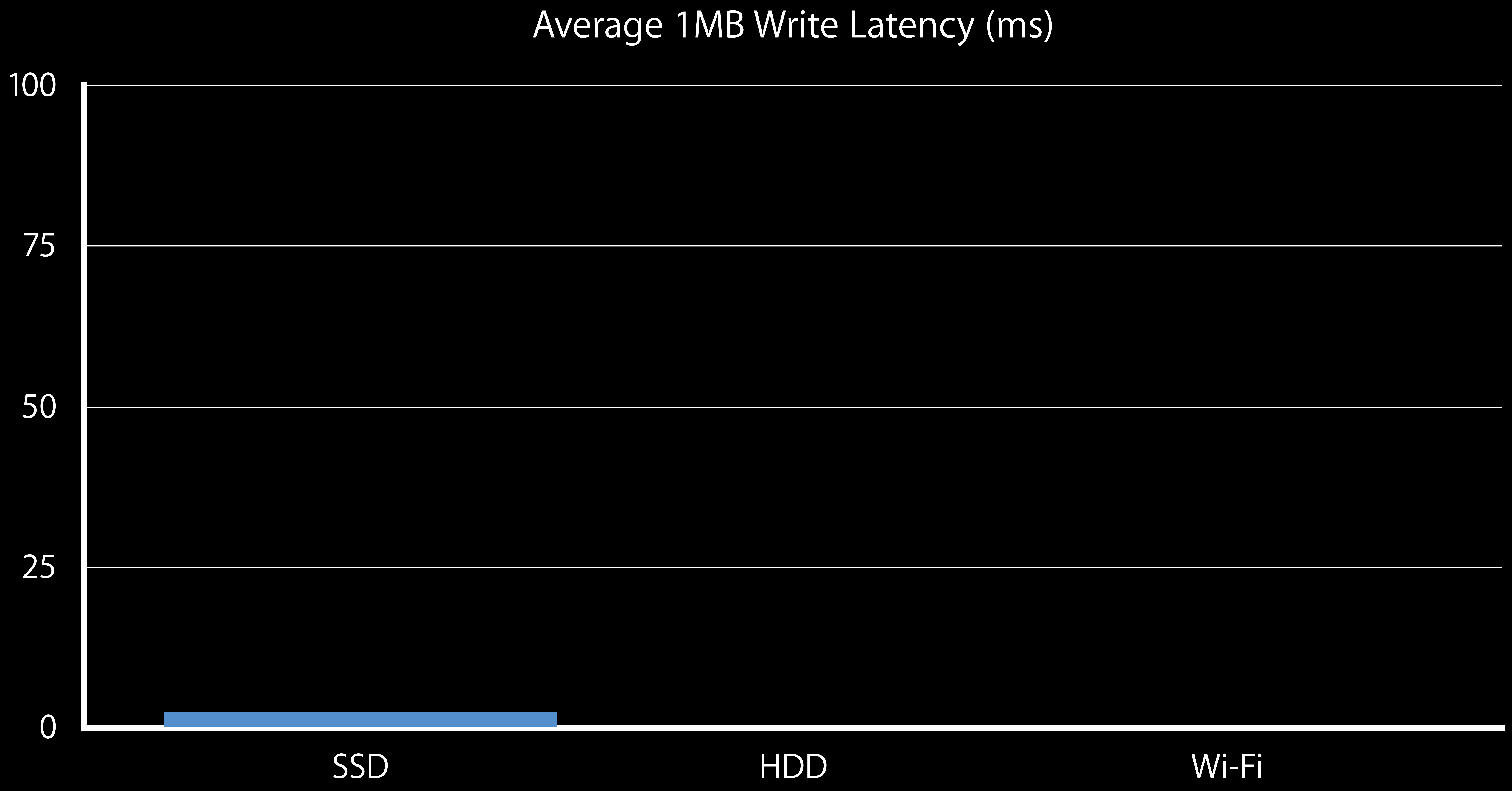
I/O Technology Variation



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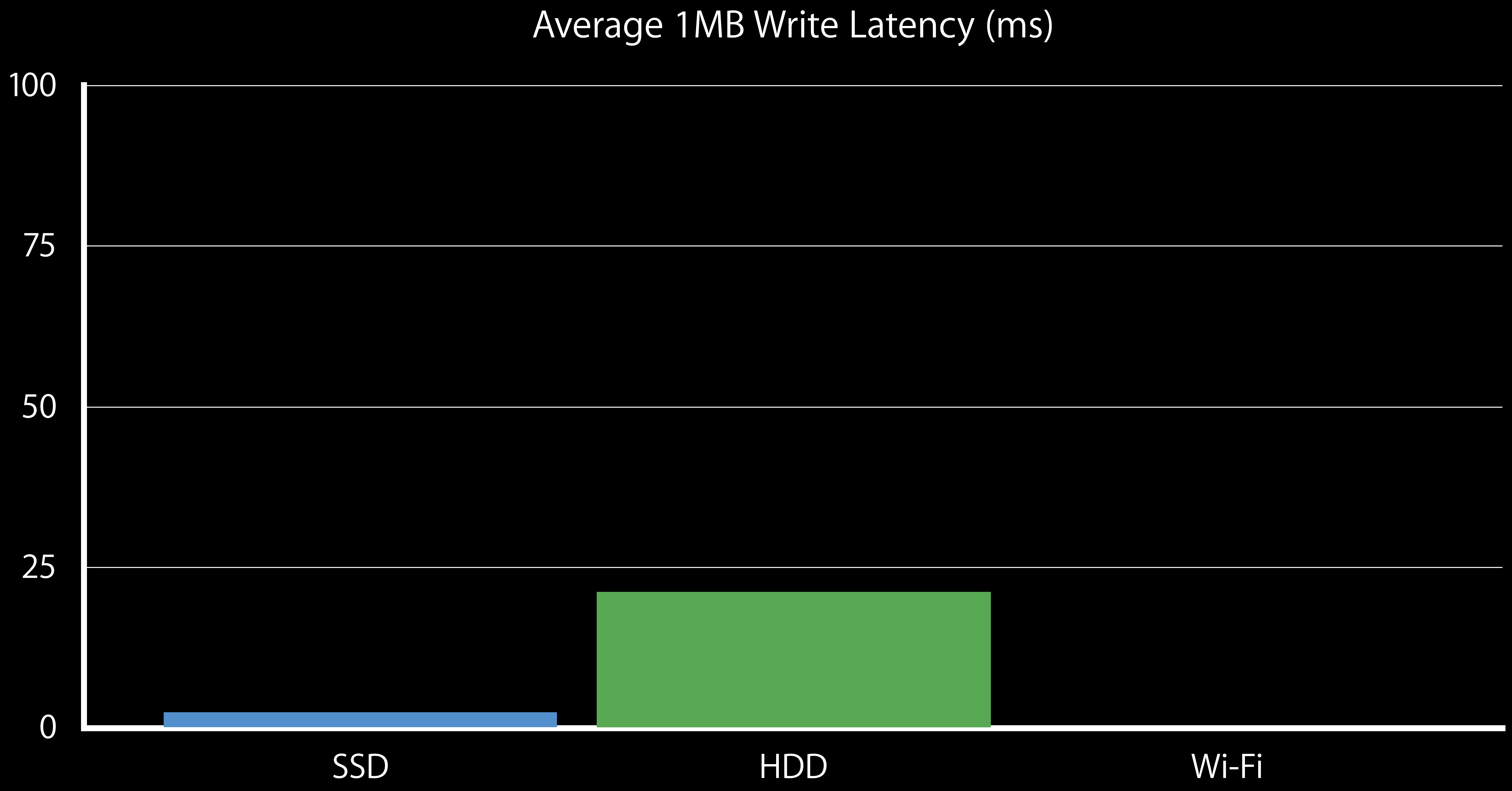

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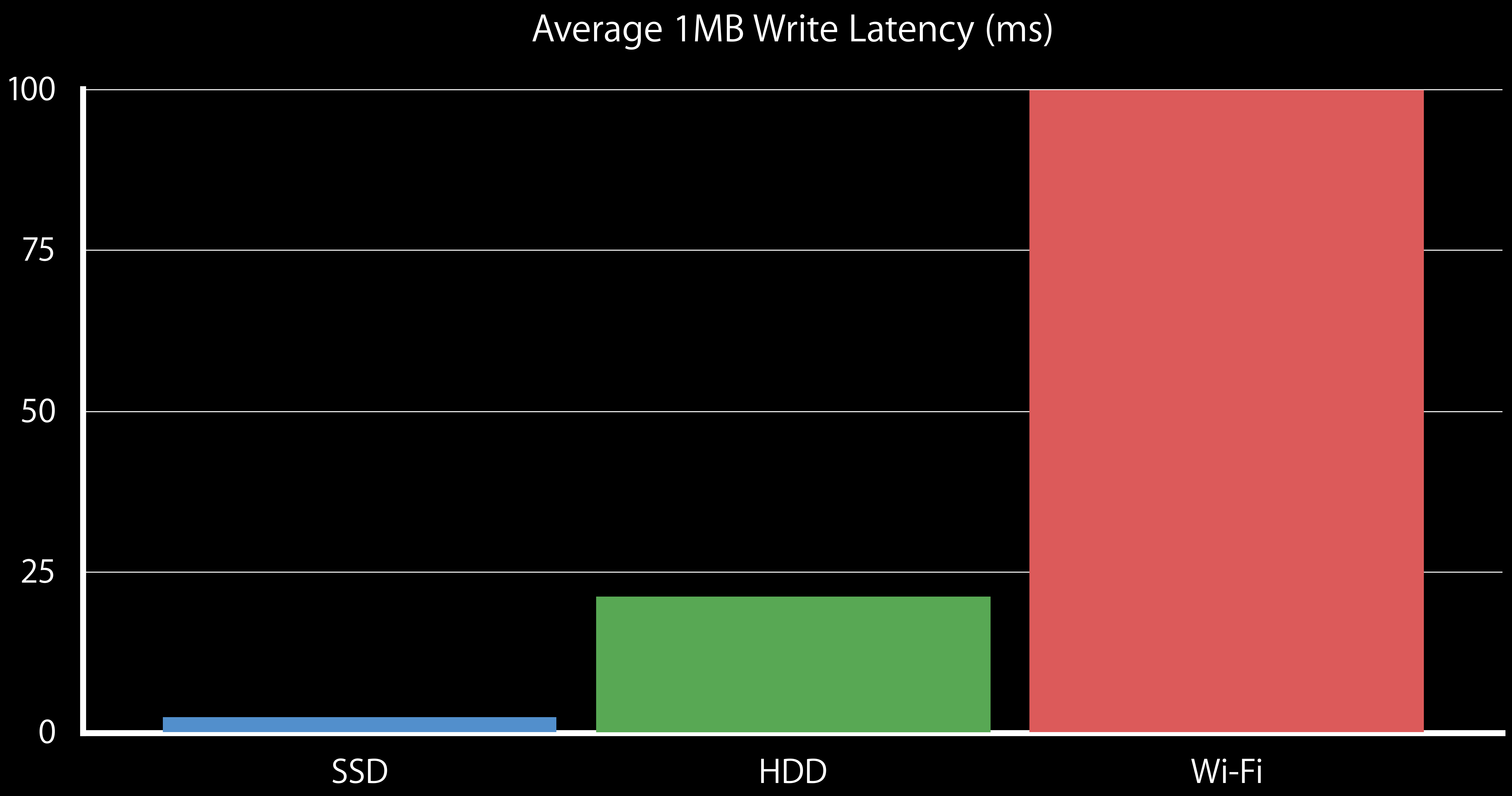

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User Impact

User Impact

App Responsiveness

User Impact

App Responsiveness

System Performance

User Impact

App Responsiveness

System Performance

Battery Life

I/O Philosophy

I/O Philosophy

Reduce I/O

I/O Philosophy

Reduce I/O

Use the right thread

I/O Philosophy

Reduce I/O

Use the right thread

Adopt appropriate APIs

I/O Philosophy

Reduce I/O

Use the right thread

Adopt appropriate APIs

Test and measure

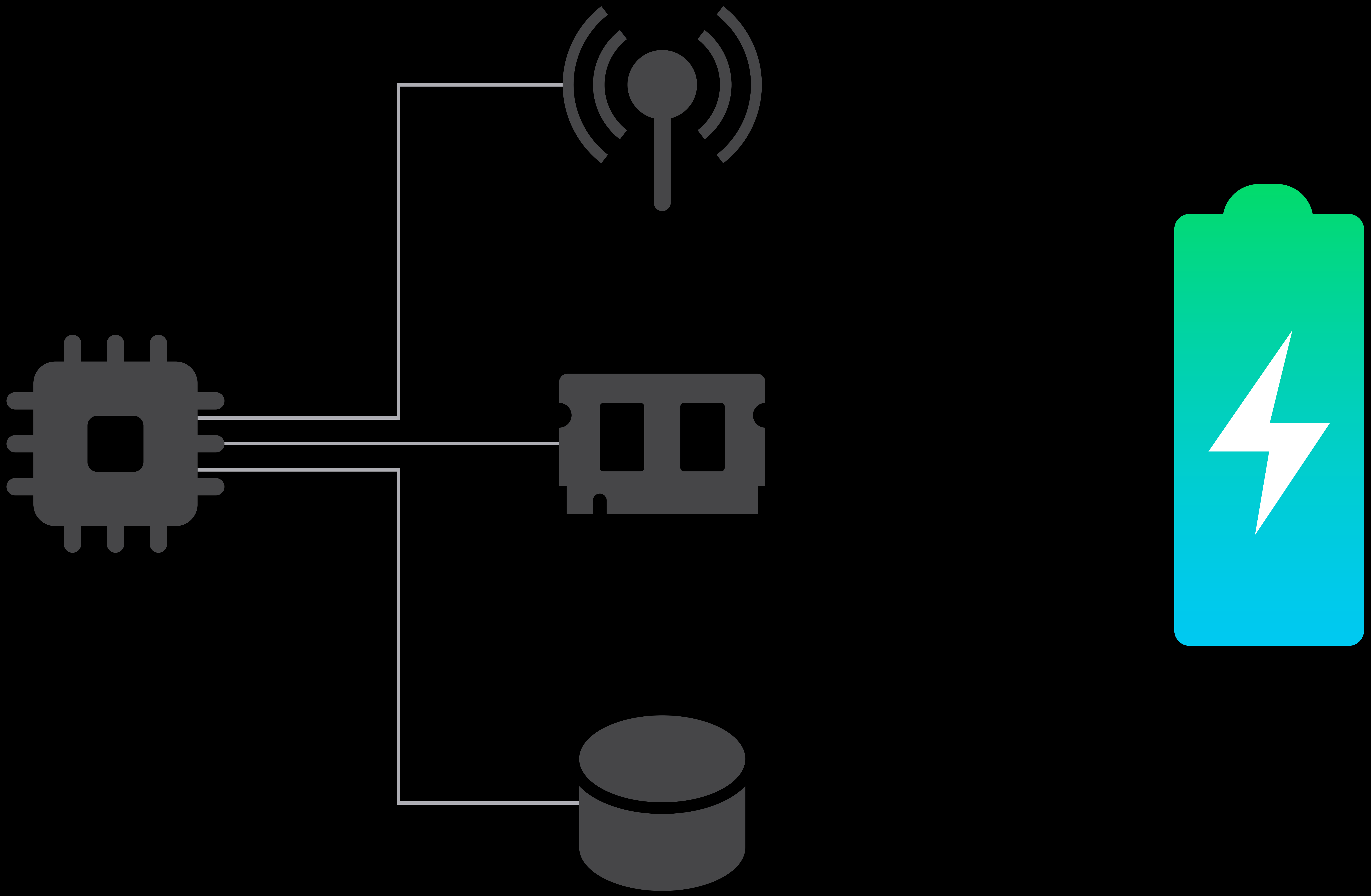
Reduce I/O

Reduce I/O

Battery life

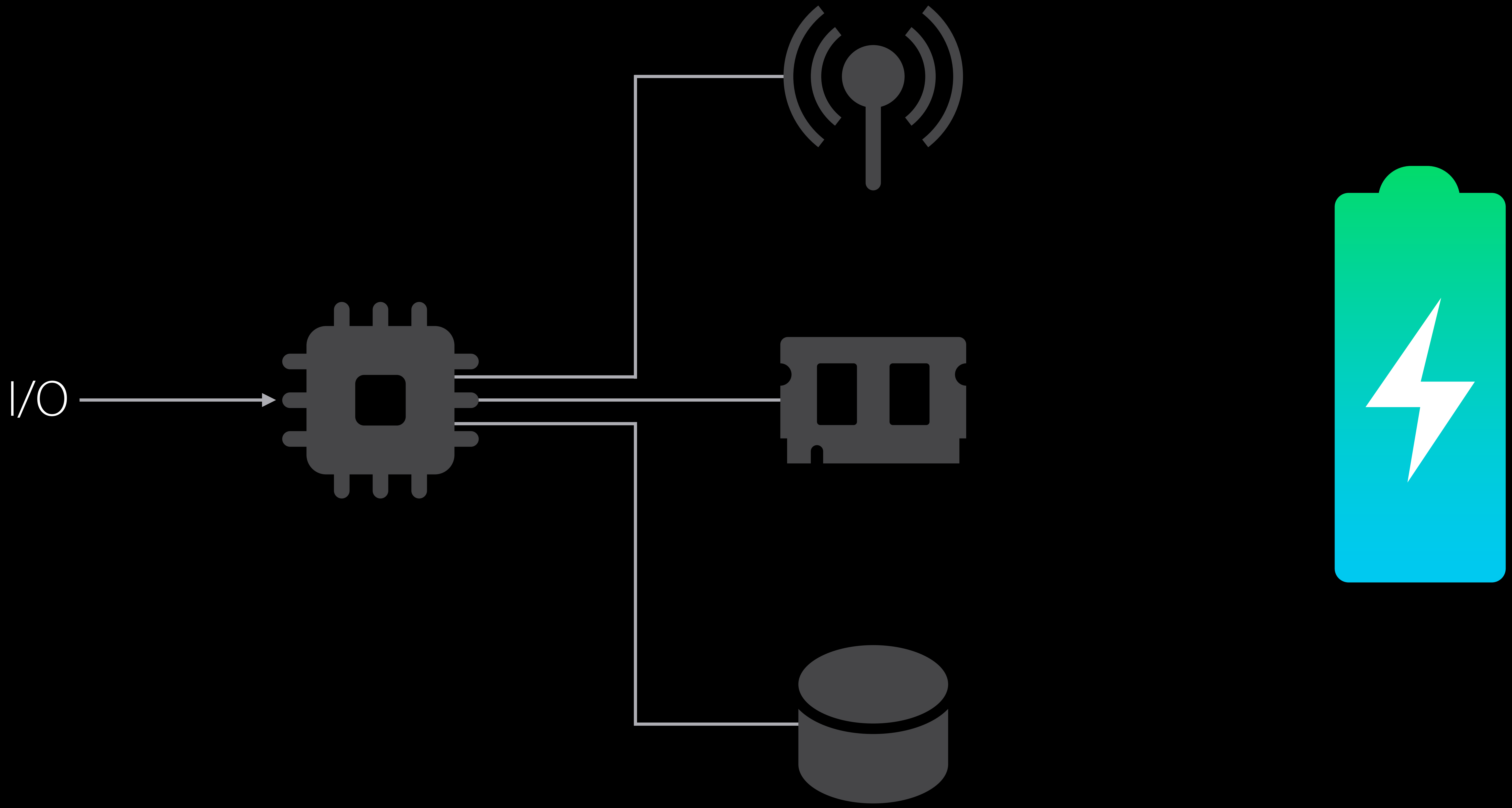
Reduce I/O

Battery life



Reduce I/O

Battery life



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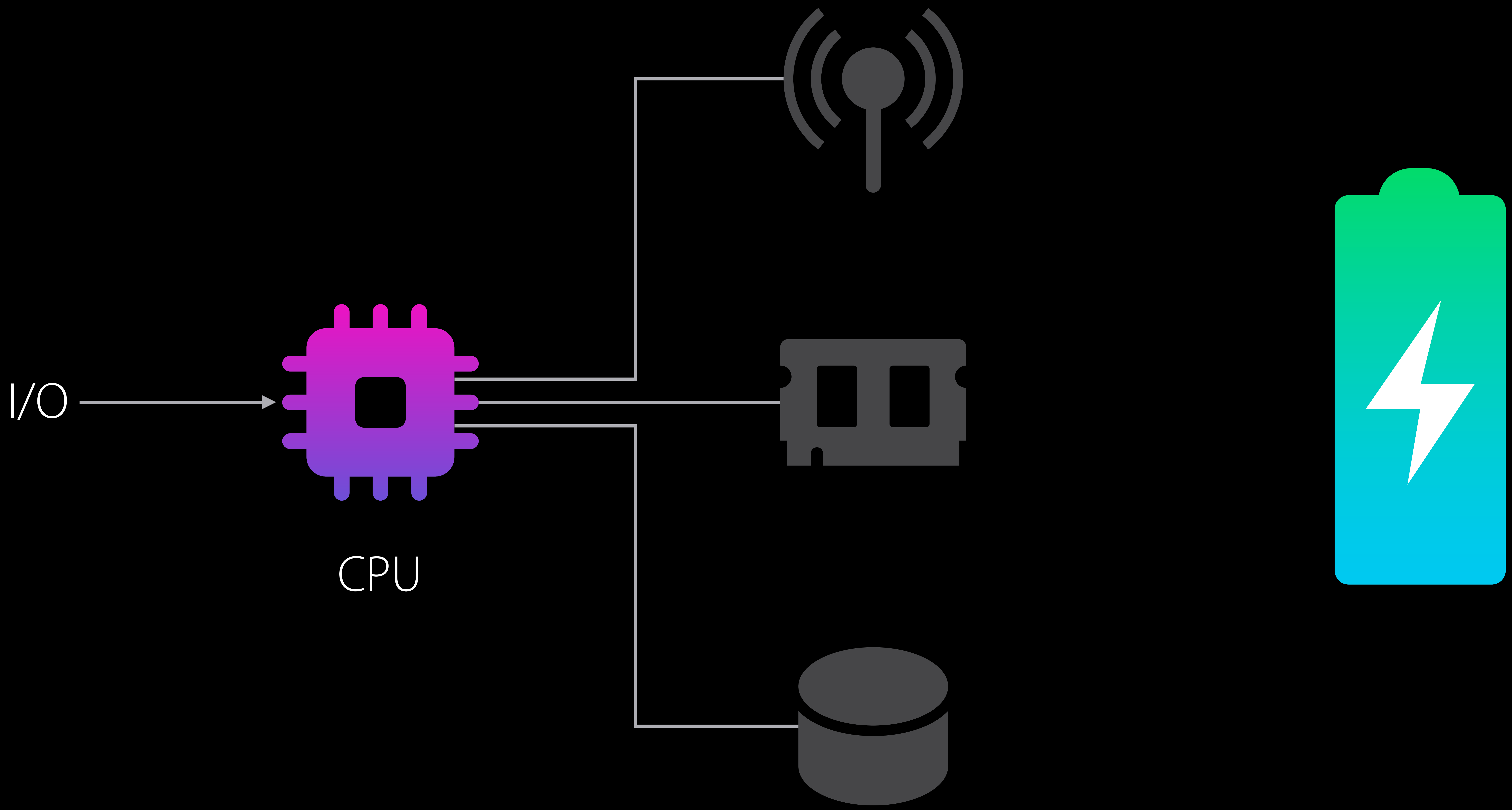
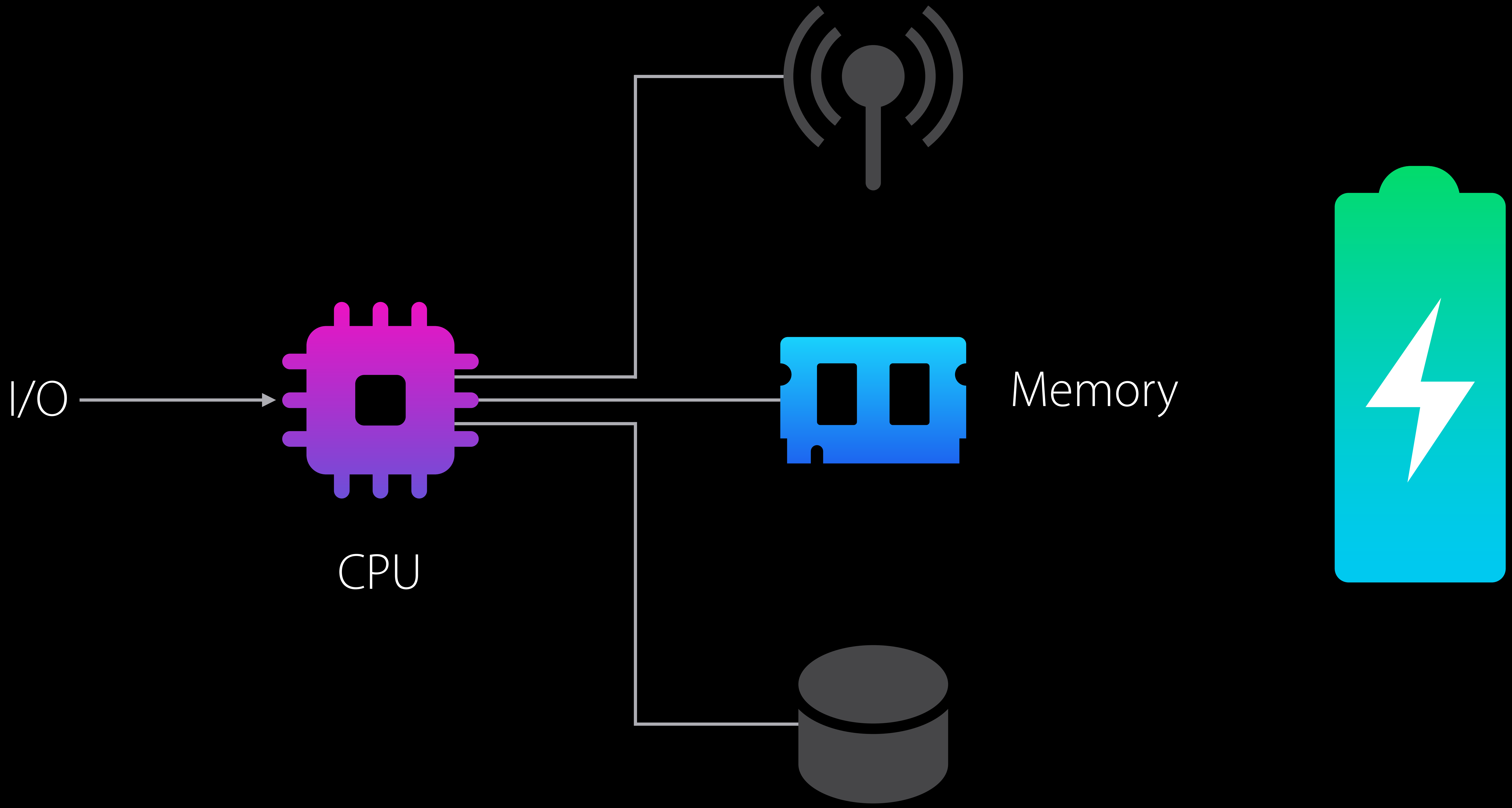


Reduce I/O

Battery life



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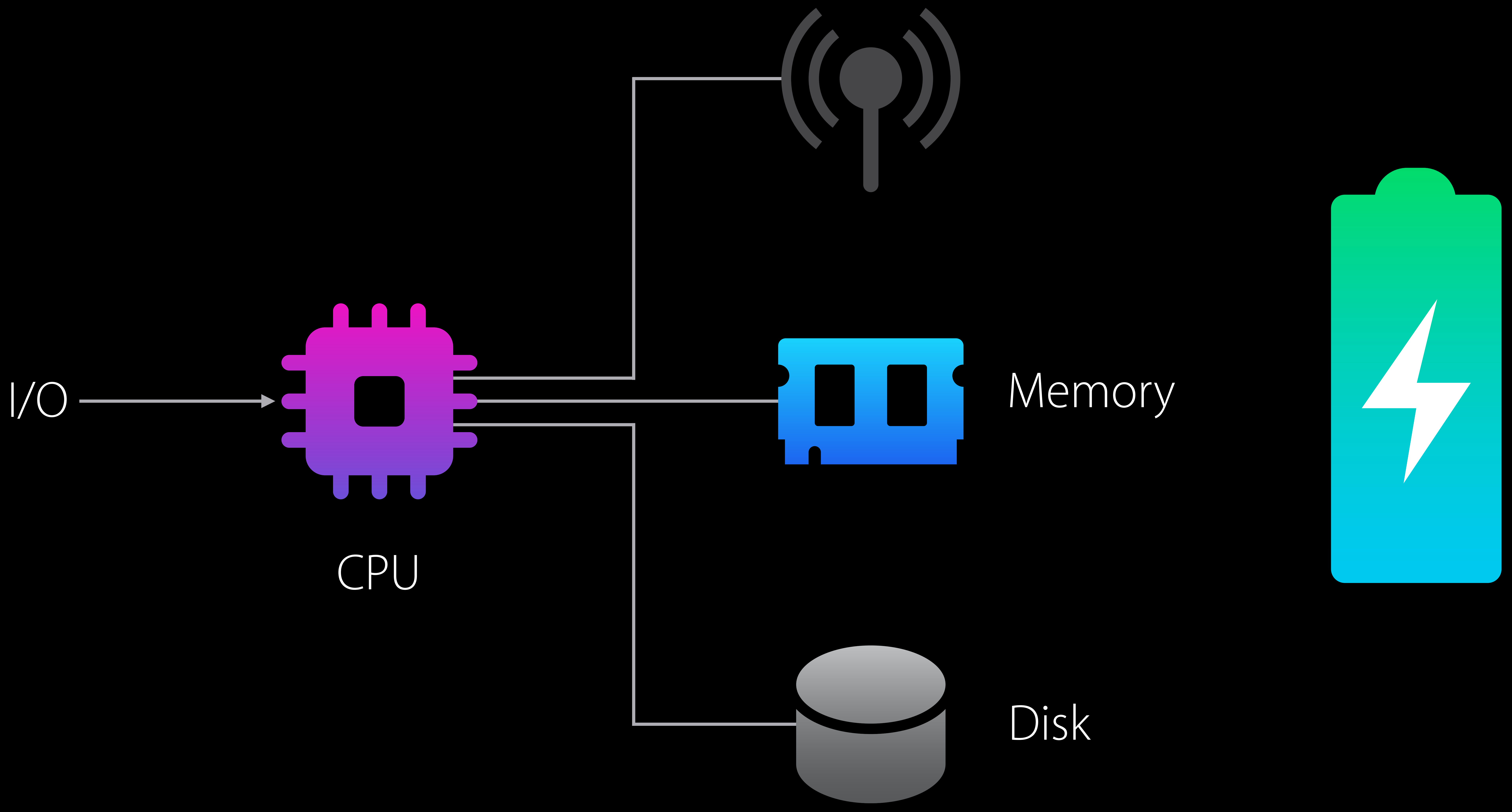
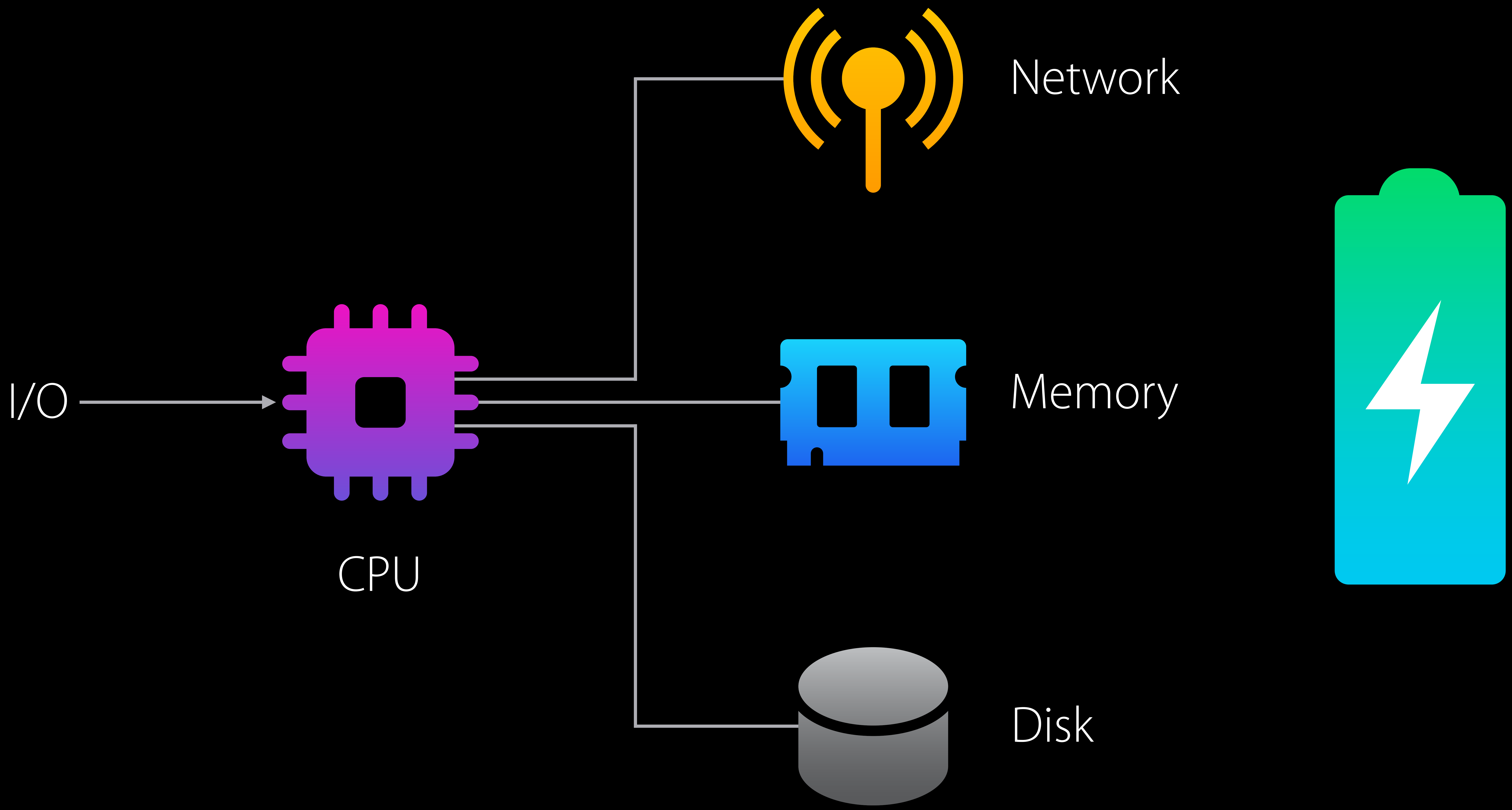
Battery life

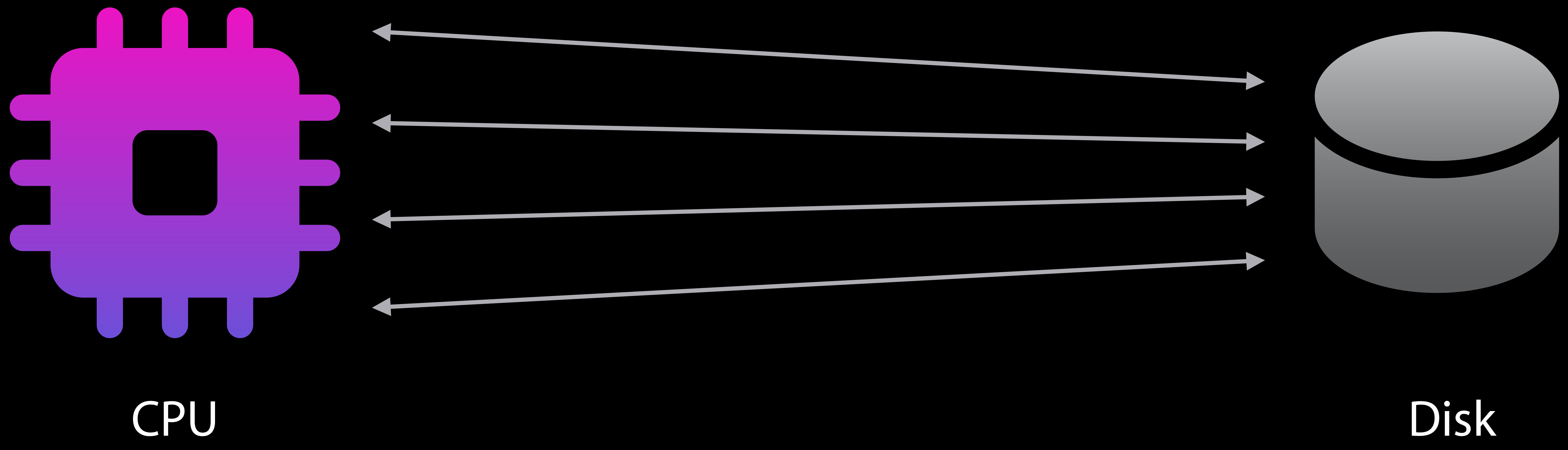


Reduce I/O

Battery life

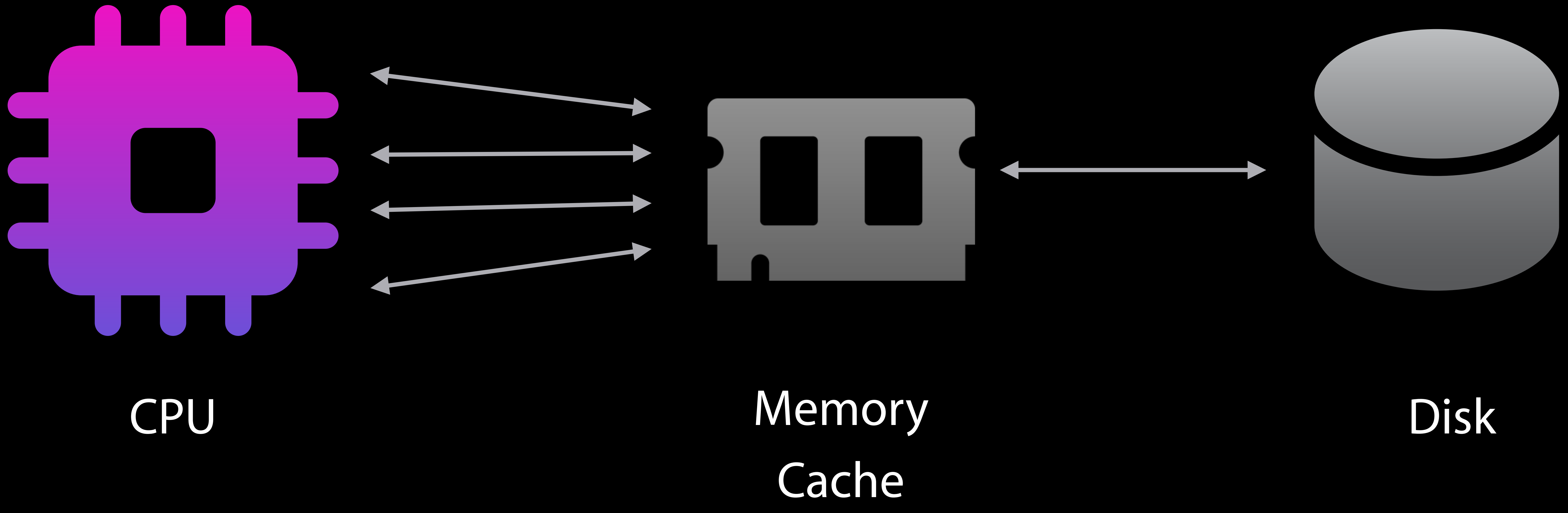


Caching



Caching

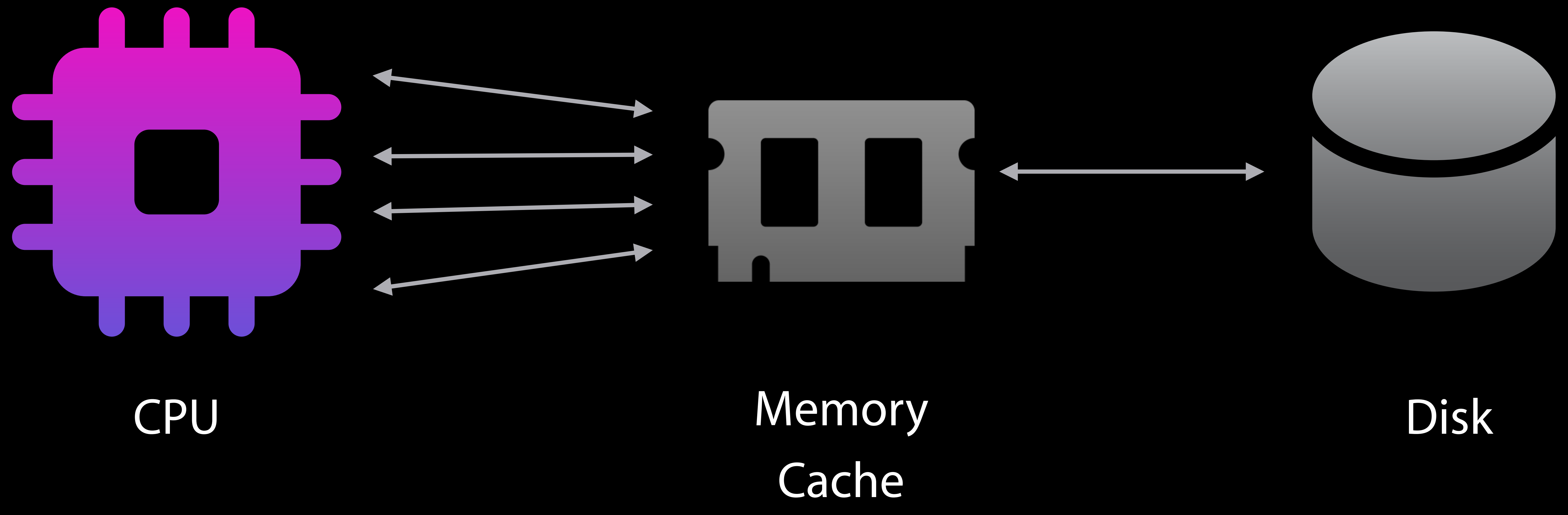
In-memory copy of data



Caching

In-memory copy of data

Potential candidates

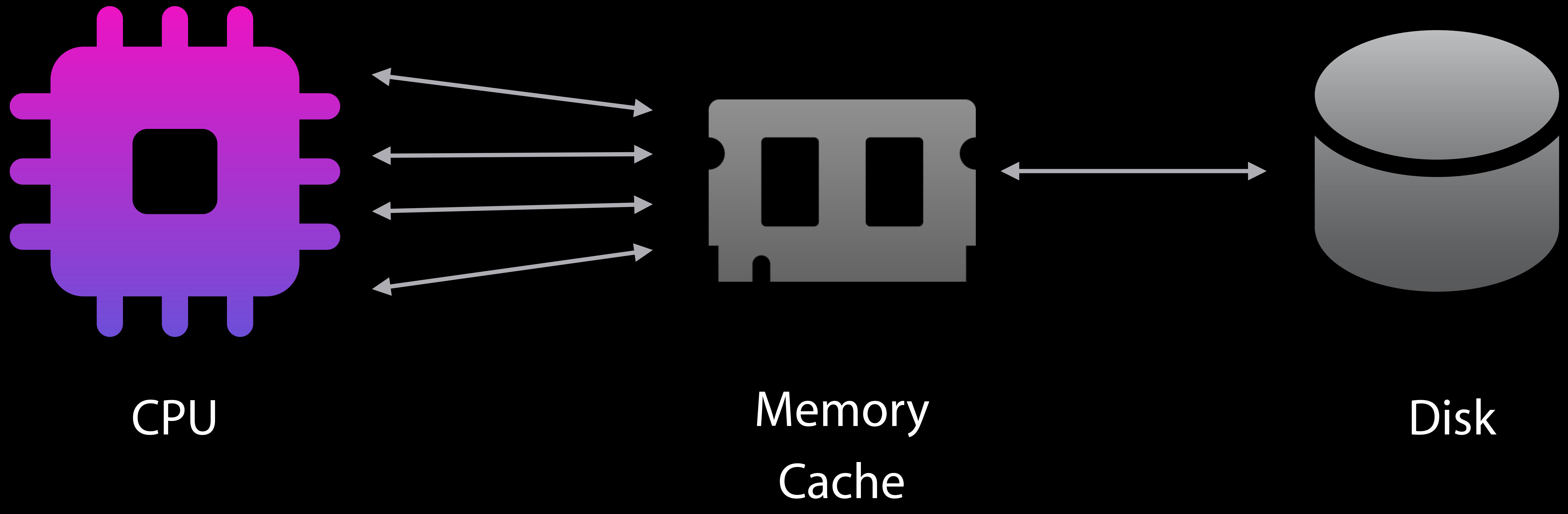


Caching

In-memory copy of data

Potential candidates

- Frequent writes

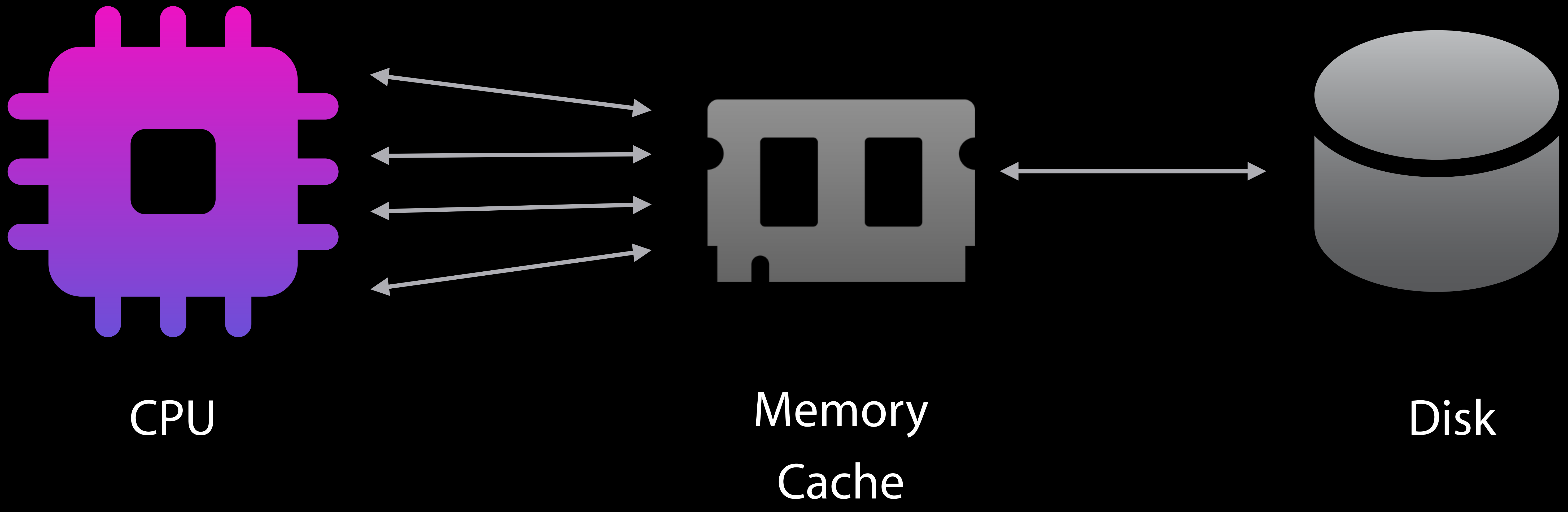


Caching

In-memory copy of data

Potential candidates

- Frequent writes
- Expensive reads



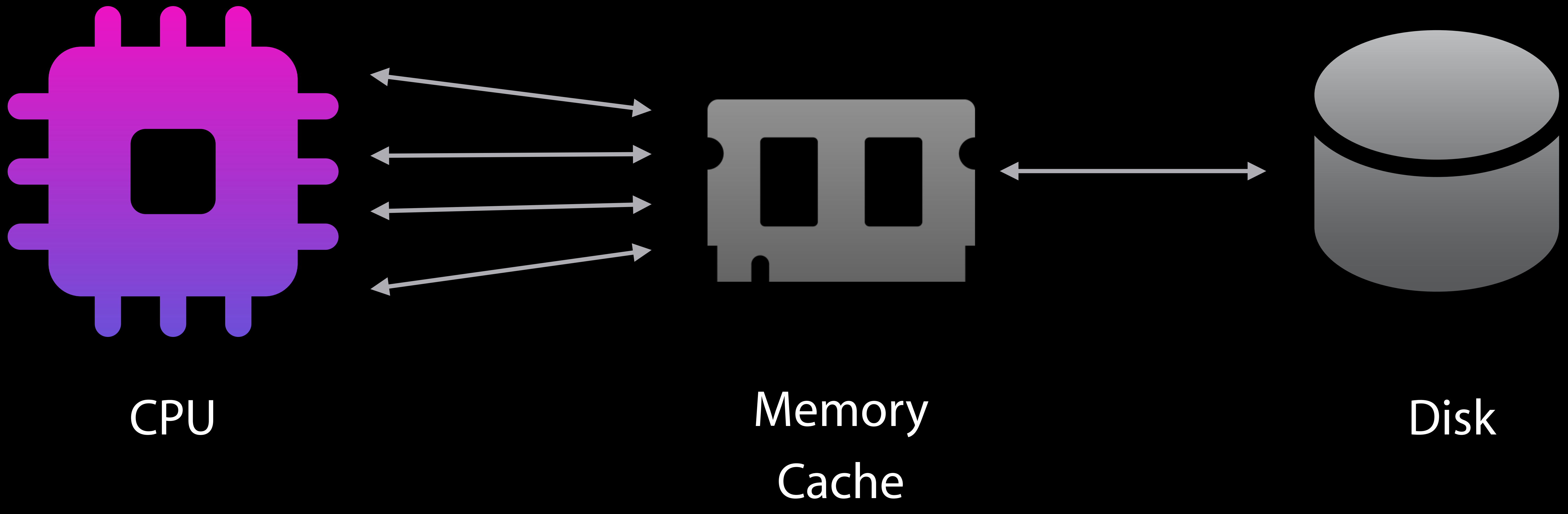
Caching

In-memory copy of data

Potential candidates

- Frequent writes
- Expensive reads

Memory and I/O tradeoffs



Caching

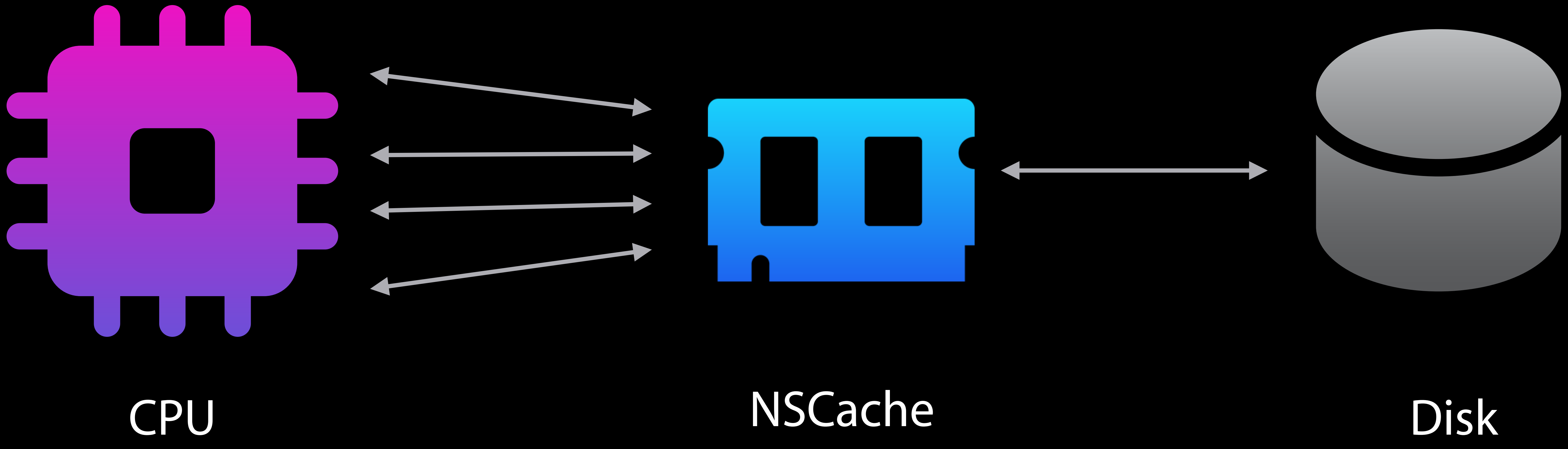
✓

In-memory copy of data

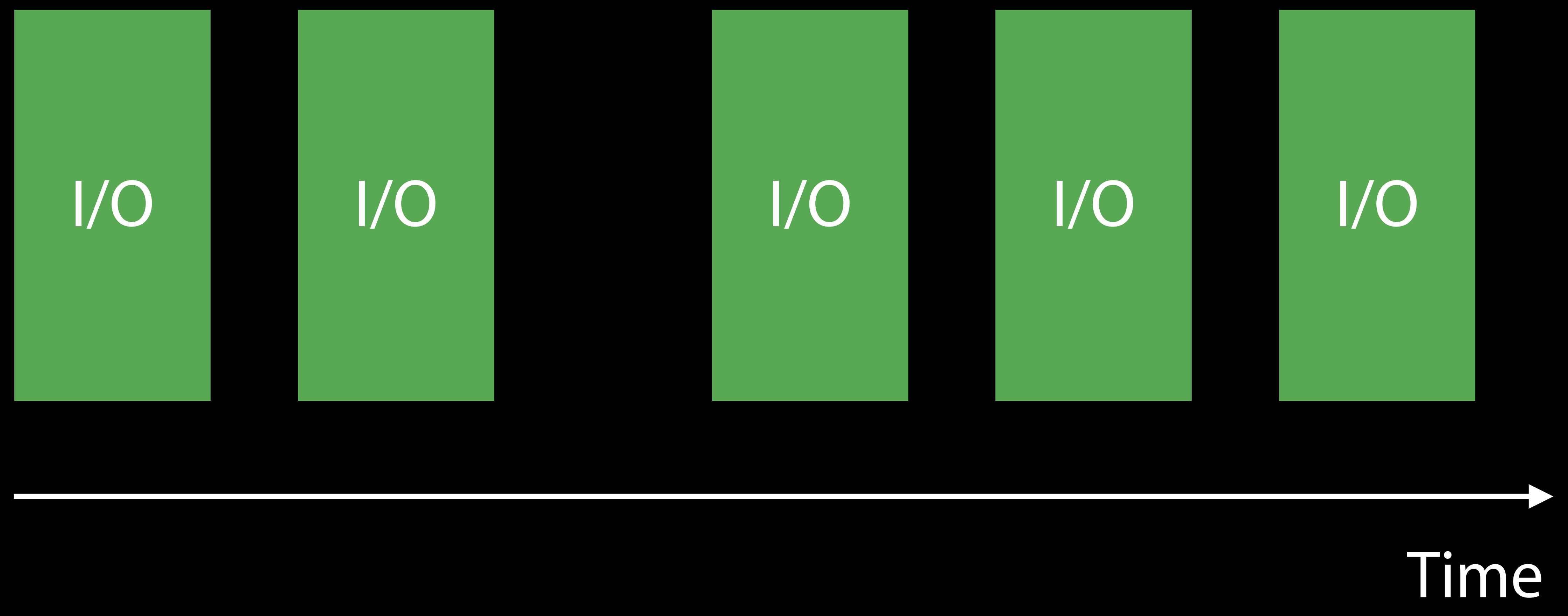
Potential candidates

- Frequent writes
- Expensive reads

Memory and I/O tradeoffs

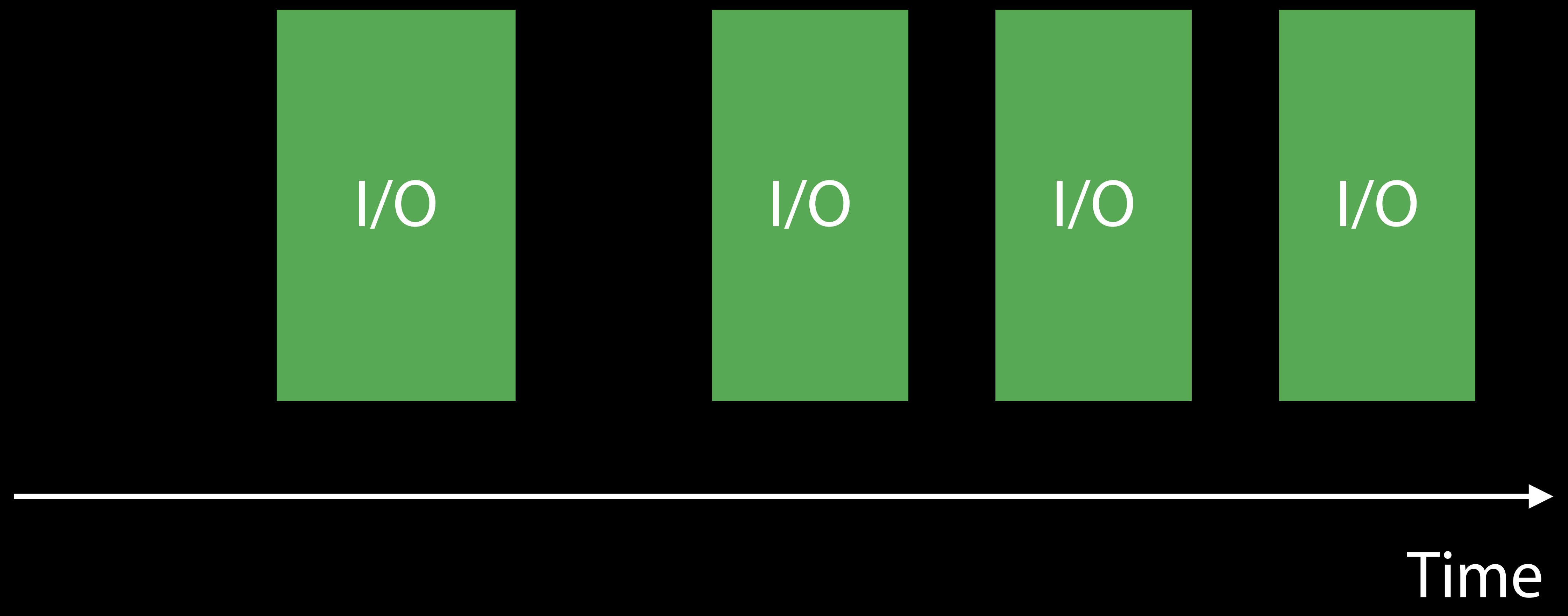


Coalescing I/O



Coalescing I/O

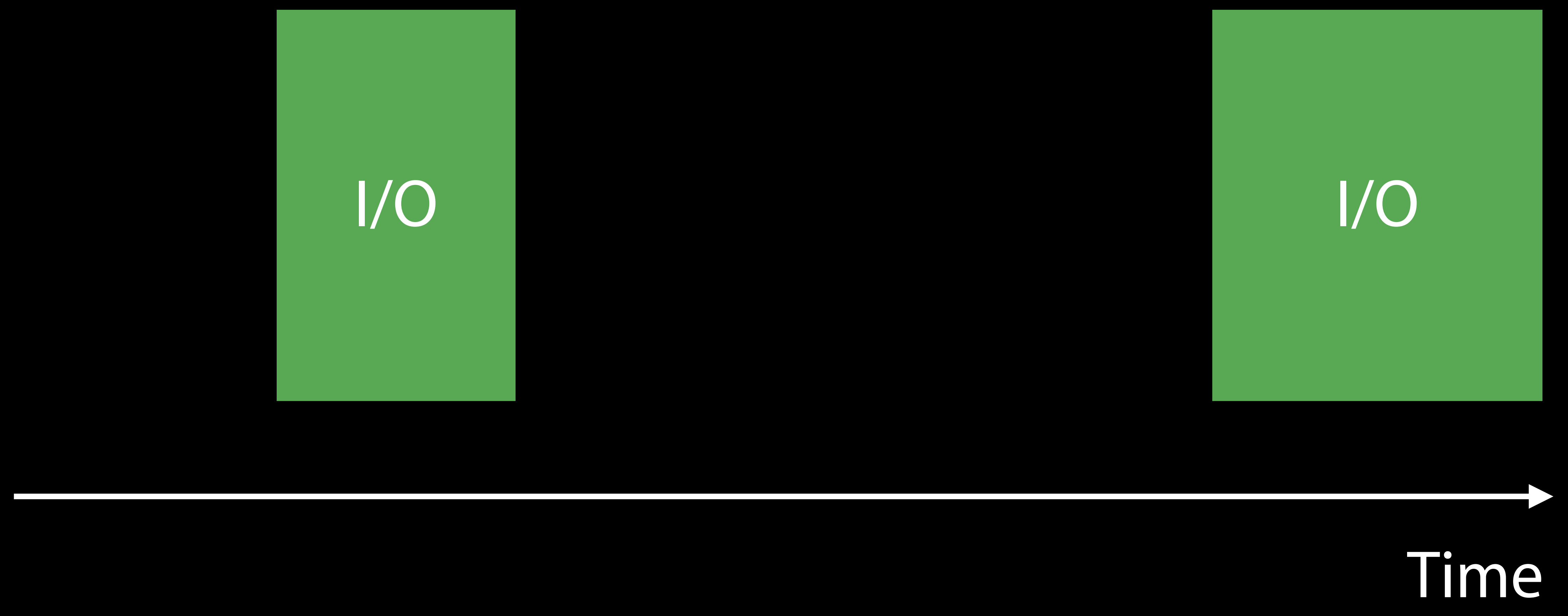
Defer I/O operations



Coalescing I/O

Defer I/O operations

Larger fewer I/Os

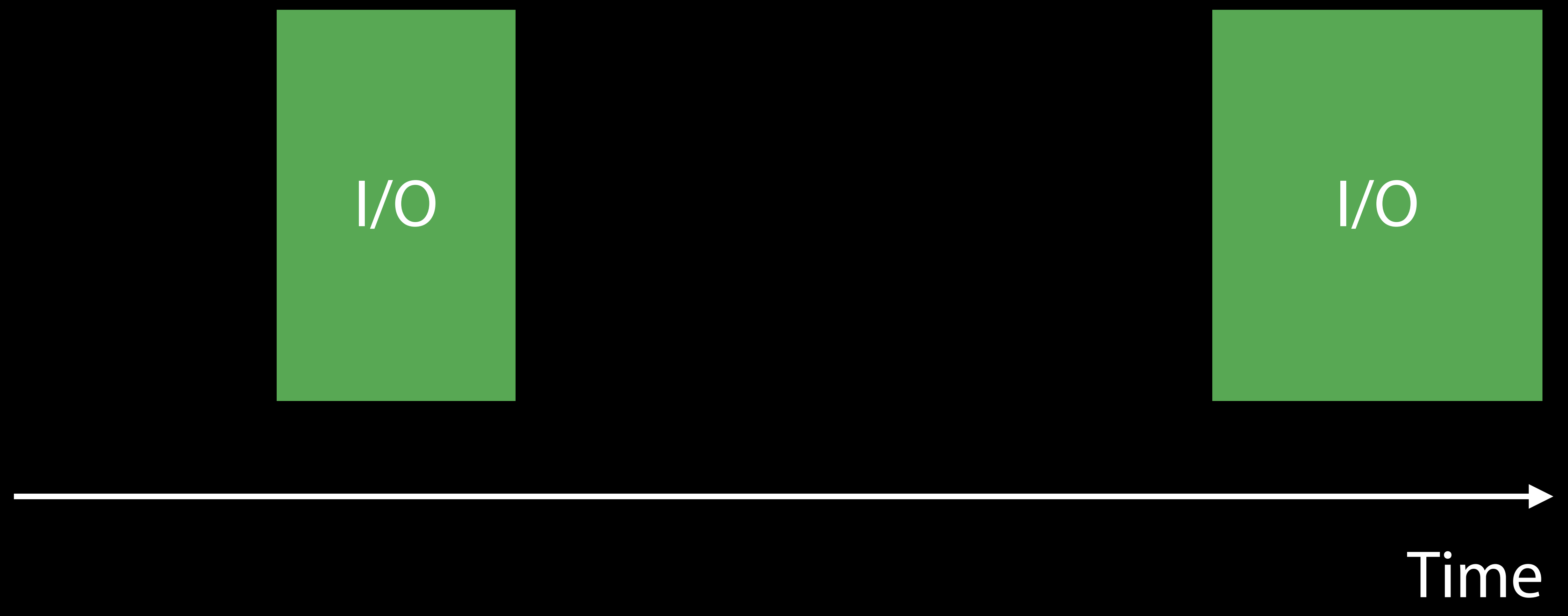


Coalescing I/O

Defer I/O operations

Larger fewer I/Os

Use app state change notifications



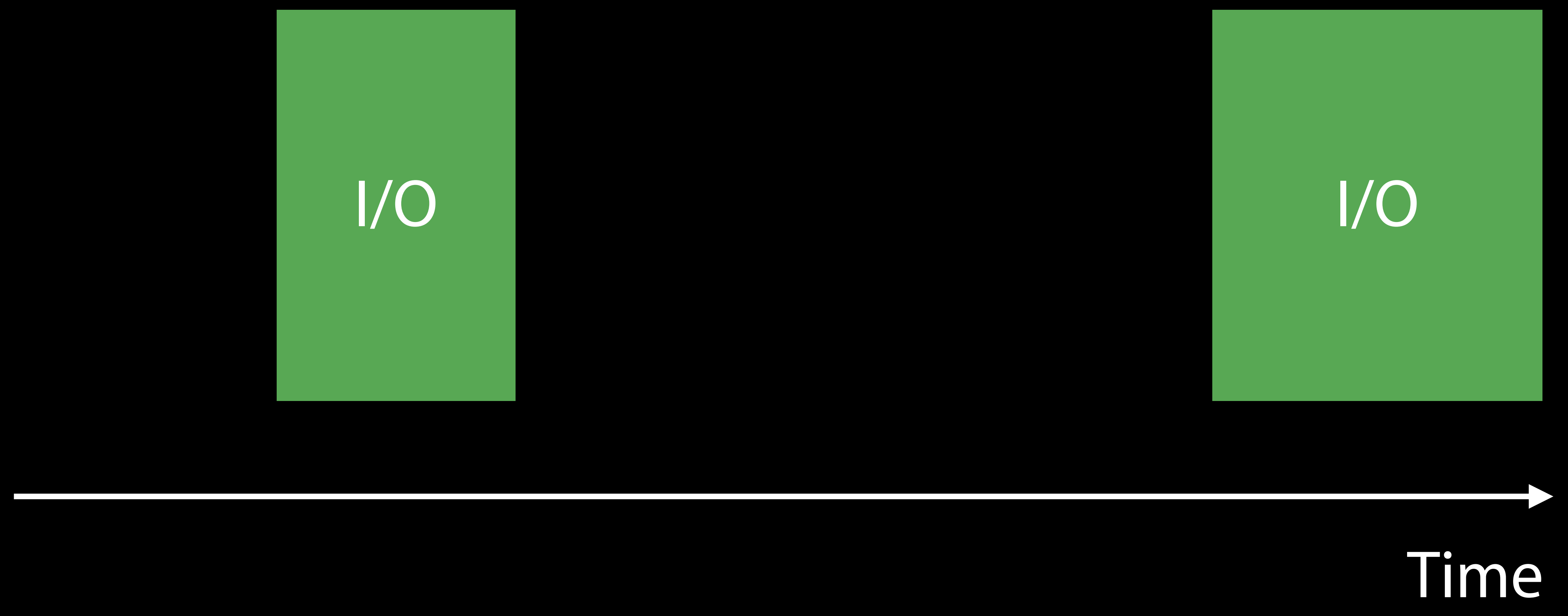
Coalescing I/O

Defer I/O operations

Larger fewer I/Os

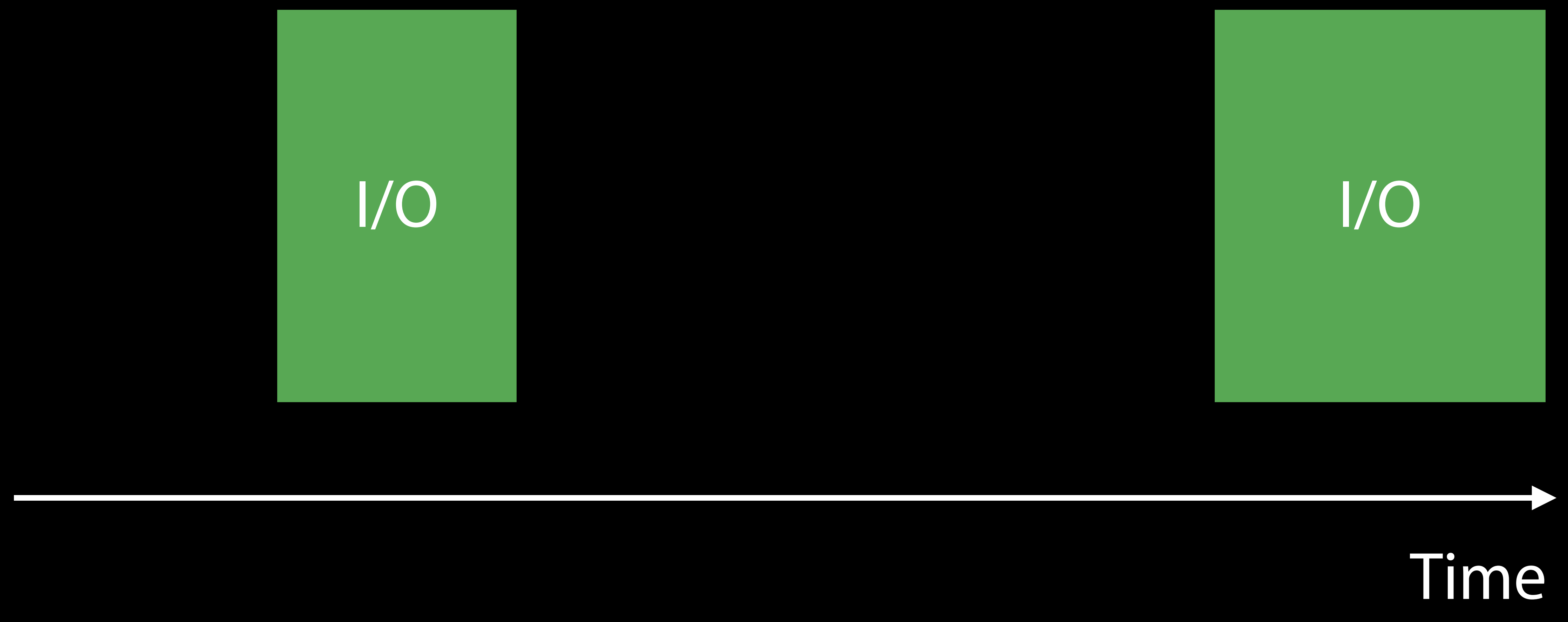
Use app state change notifications

Use Centralized Task Scheduling (macOS)

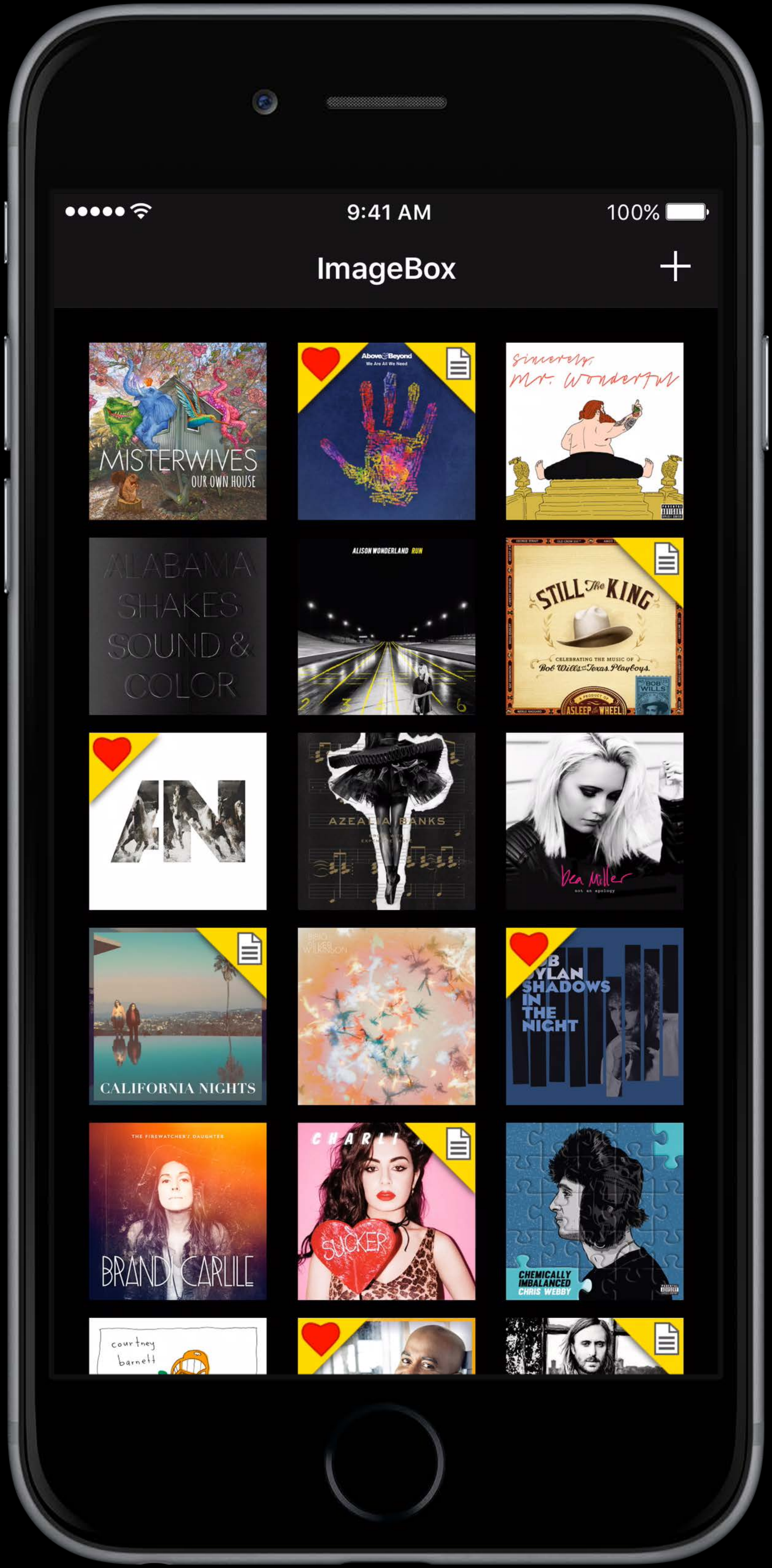


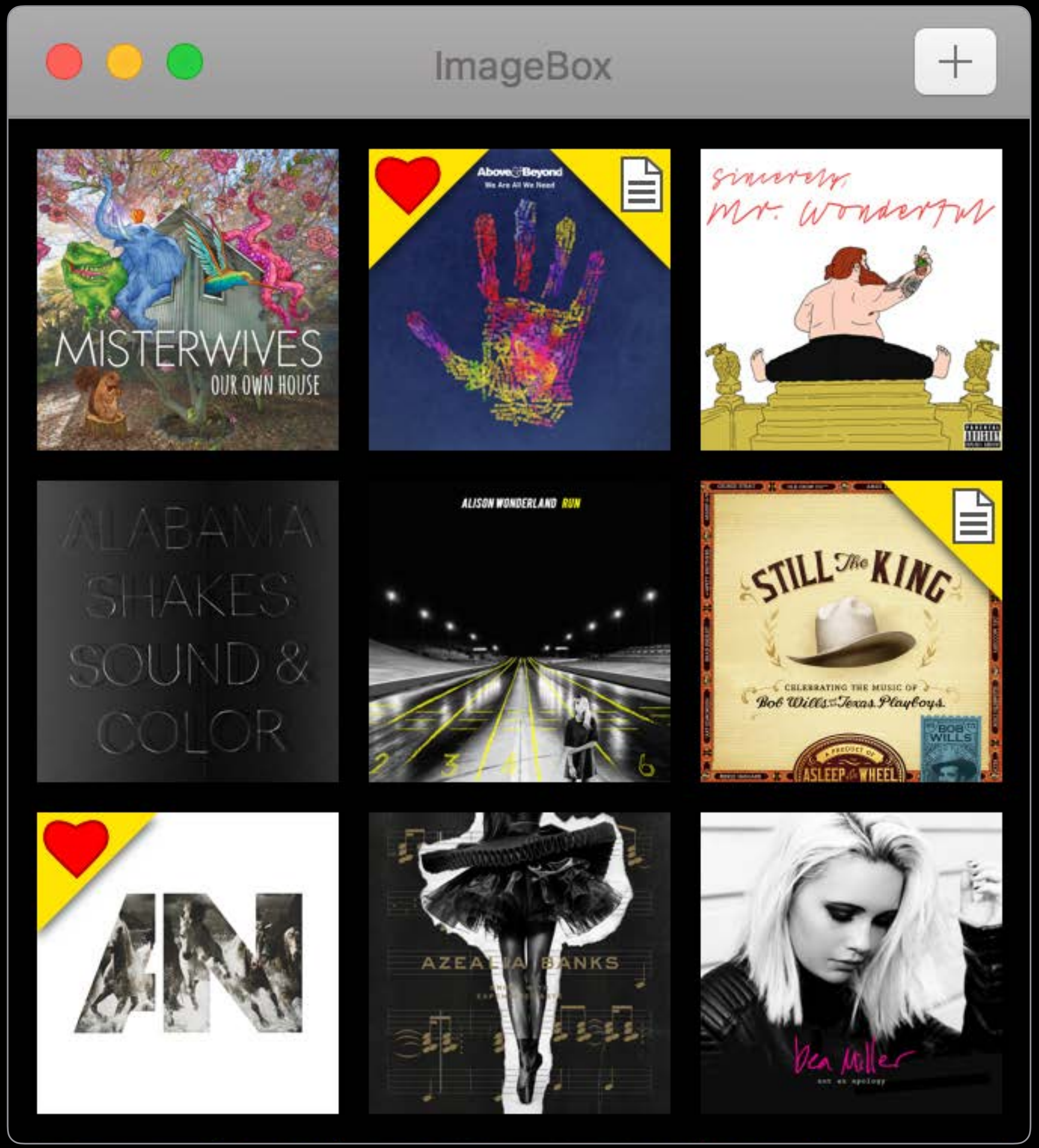
Coalescing I/O

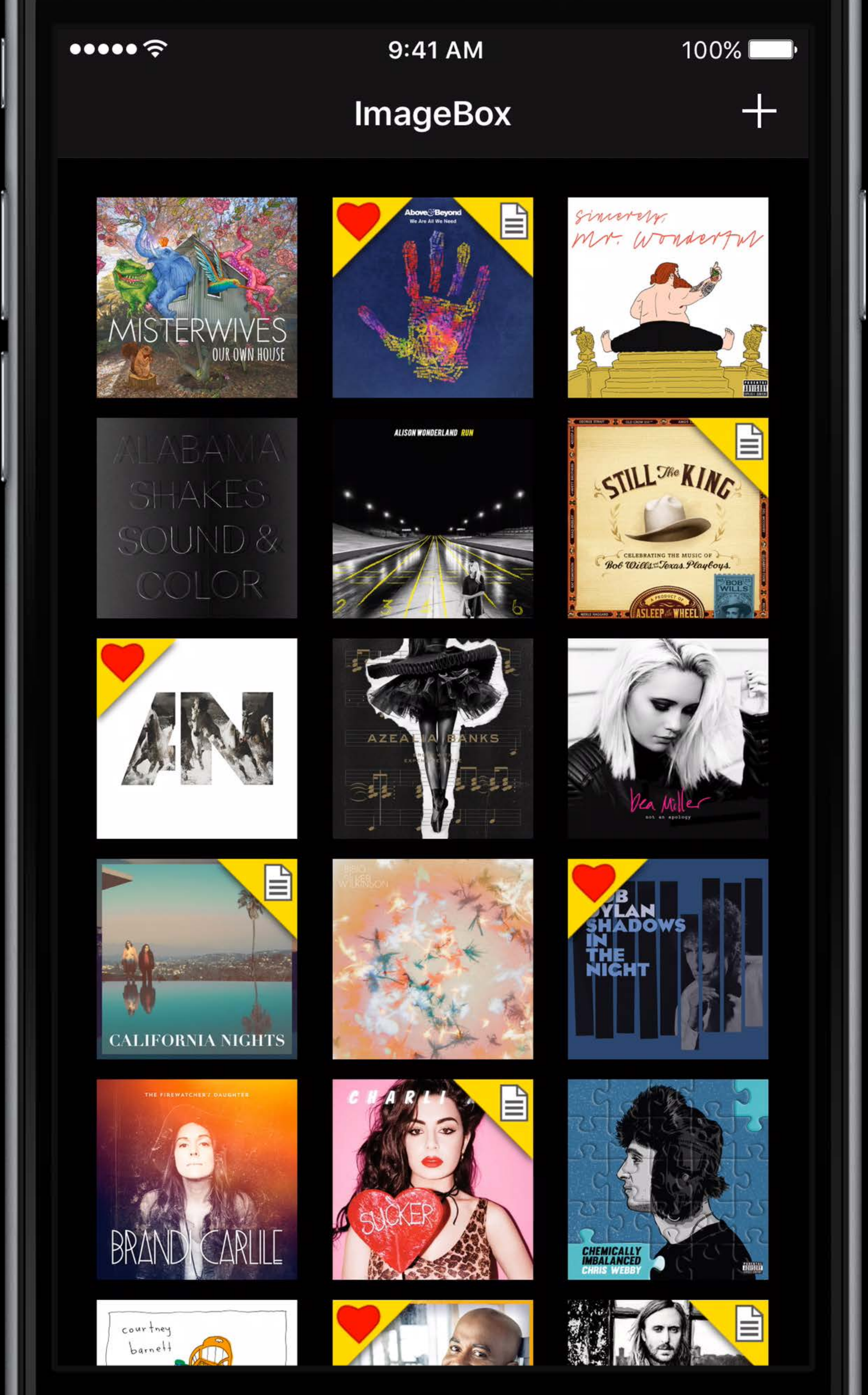
- Defer I/O operations
- Larger fewer I/Os
- Use app state change notifications
- Use Centralized Task Scheduling (macOS)



ImageBox






9:41 AM
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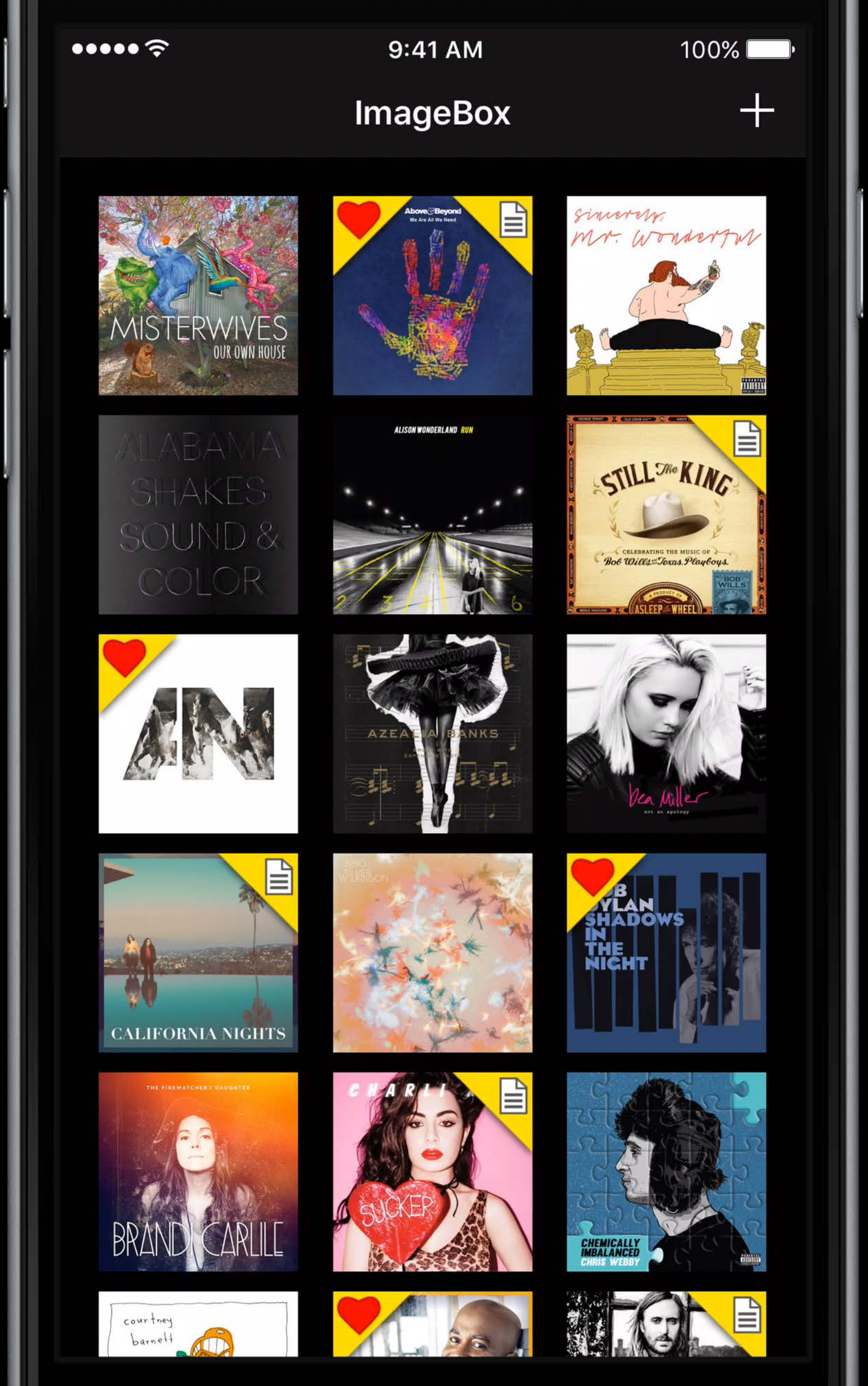
MISTERWIVES
OUR OWN HOUSE
Sincerely, Mr. Wonderful
ALABAMA SHAKES SOUND & COLOR
STILL The KING
AZEALIA BANKS
Bea Miller
CALIFORNIA NIGHTS
BOB DYLAN SHADOWS IN THE NIGHT
BRANDI CARLILE
CHARLI
SUCKER
CHEMICALLY IMBALANCED CHRIS WEBBY
courtney barnett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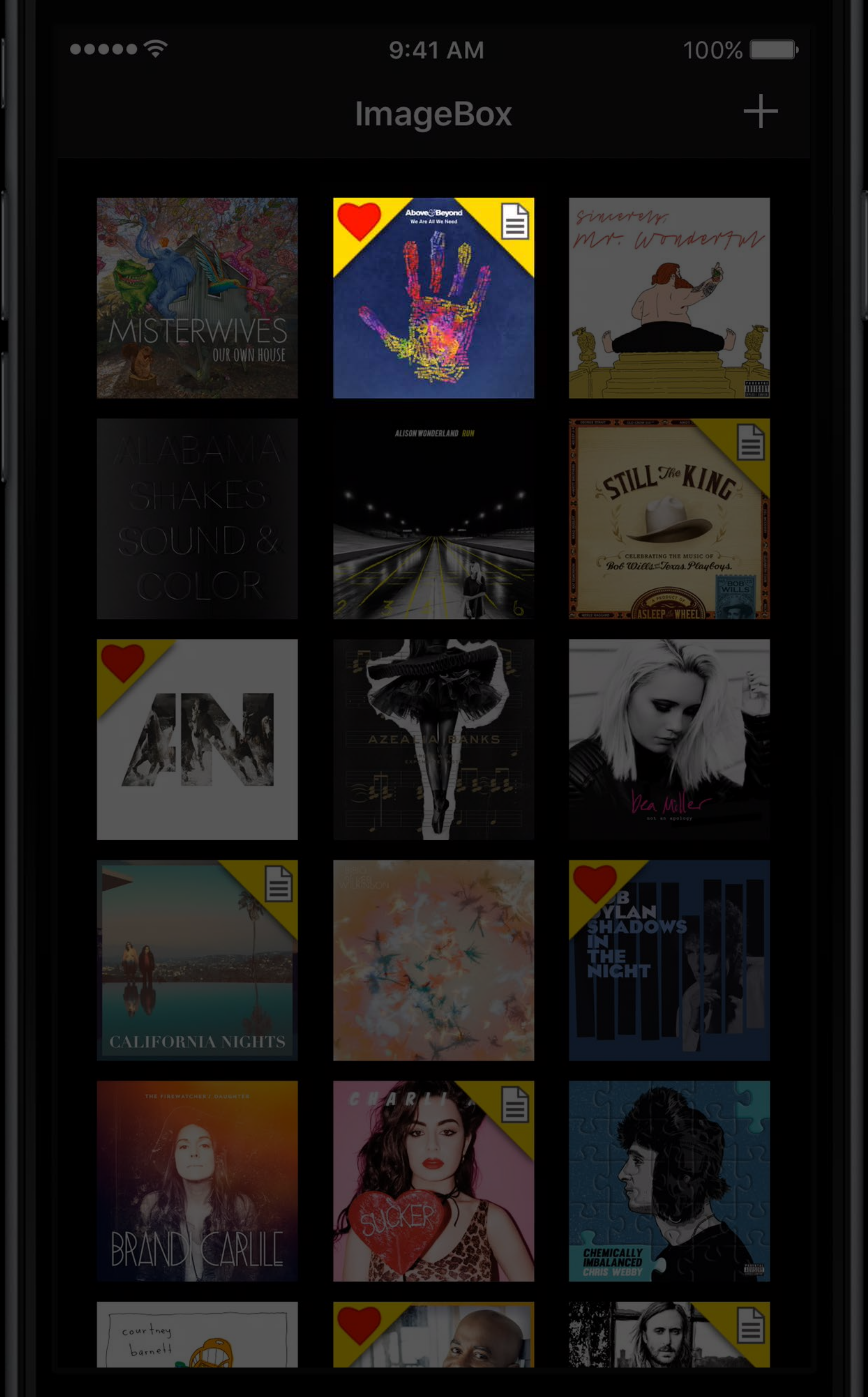
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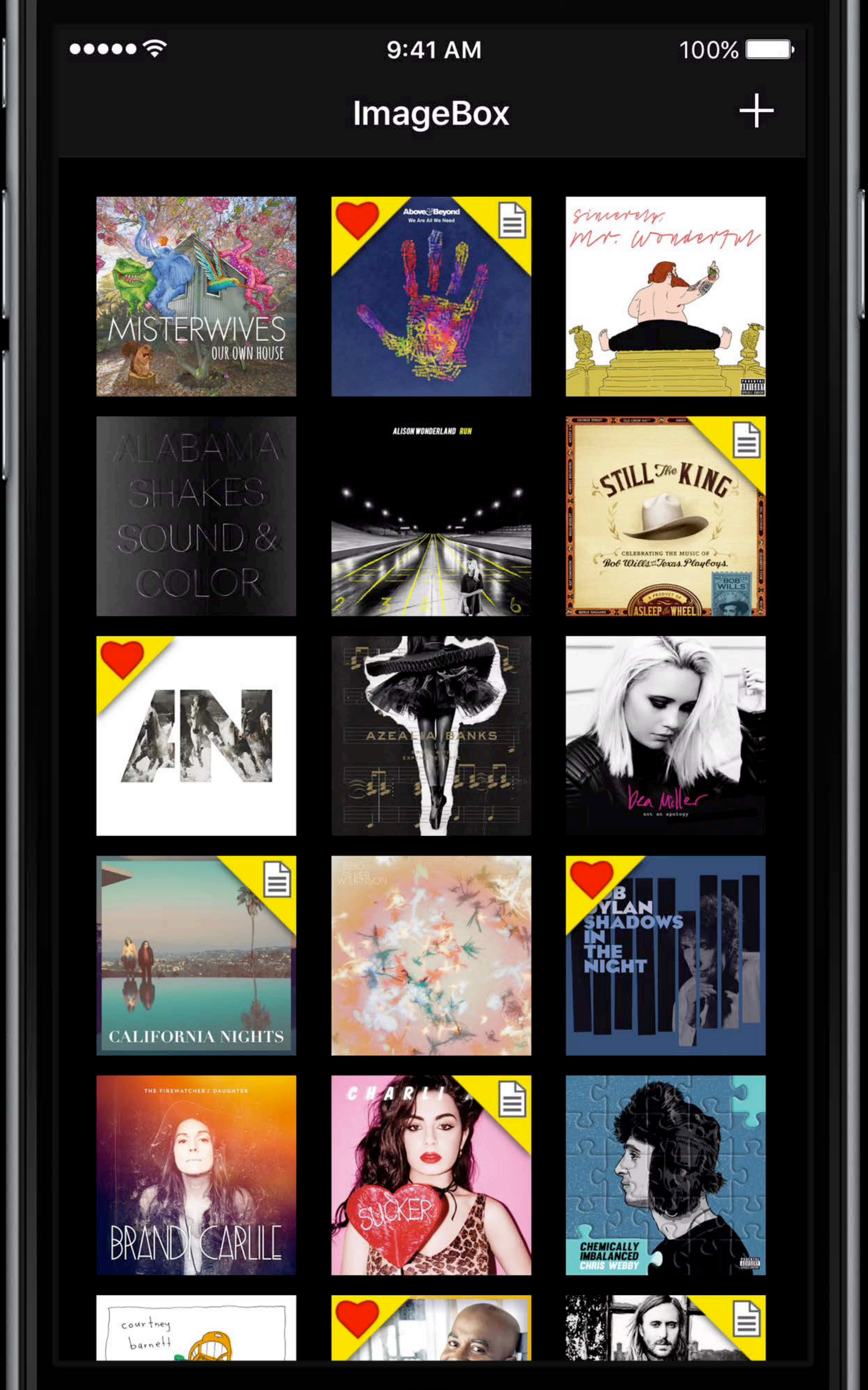
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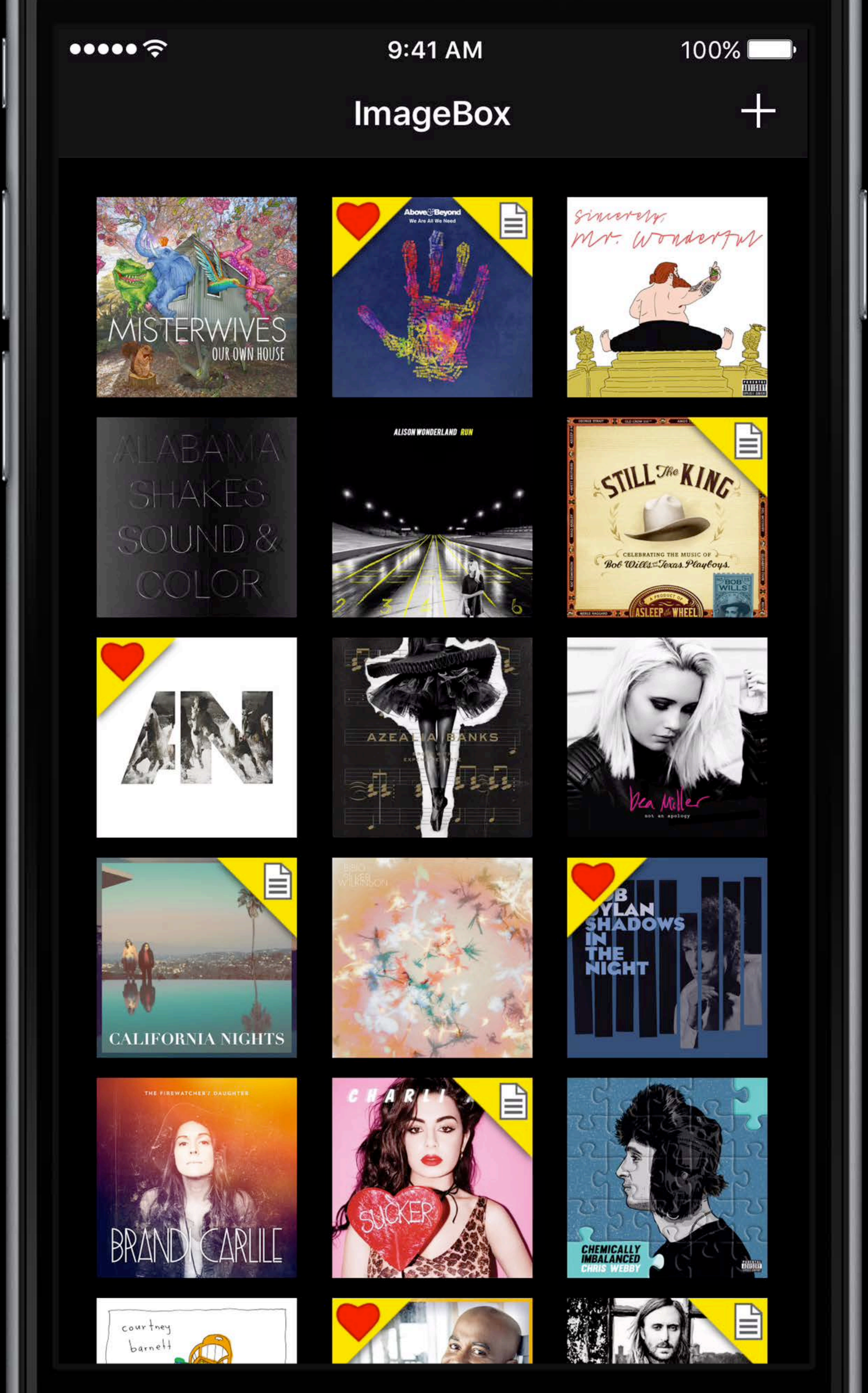
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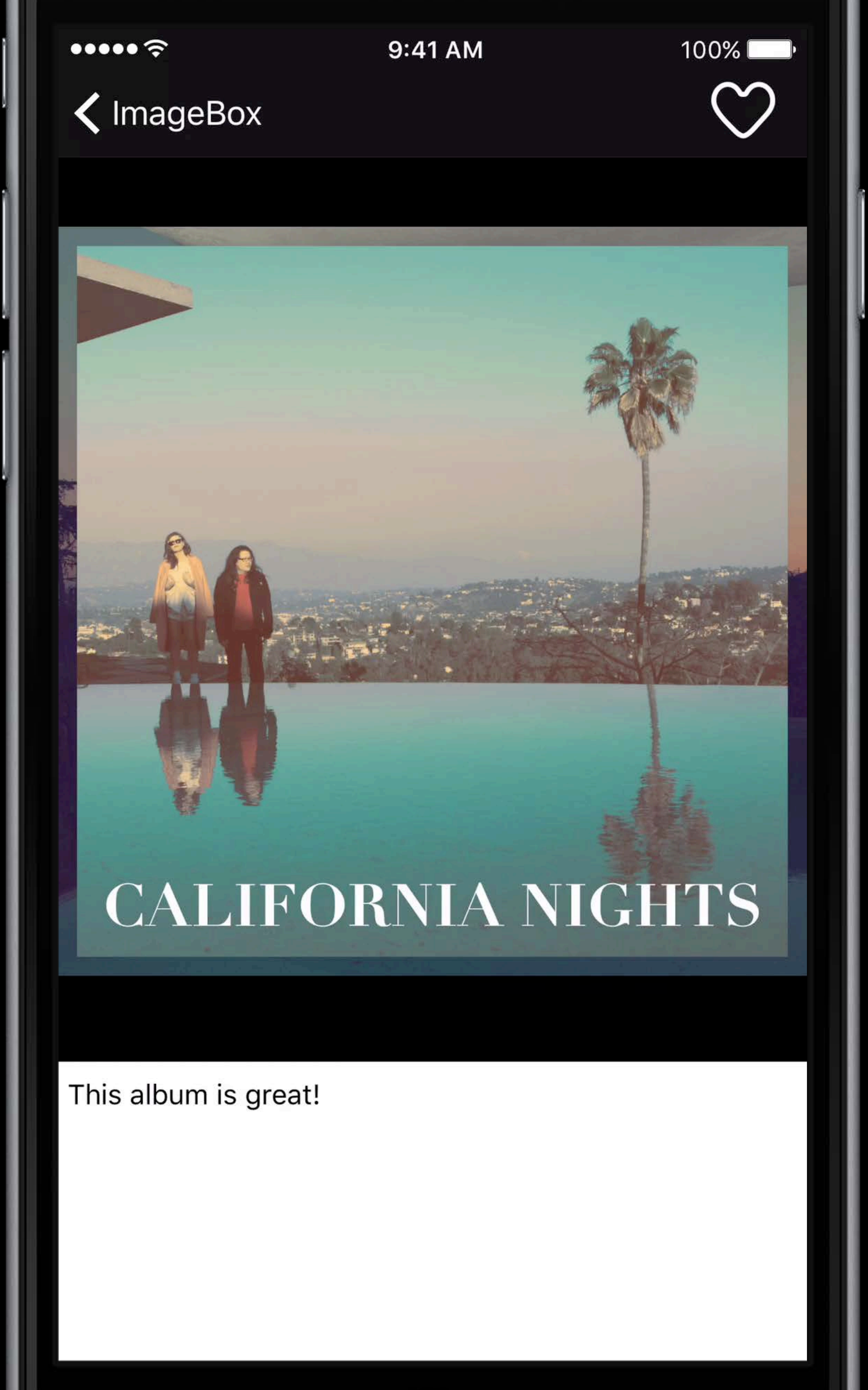
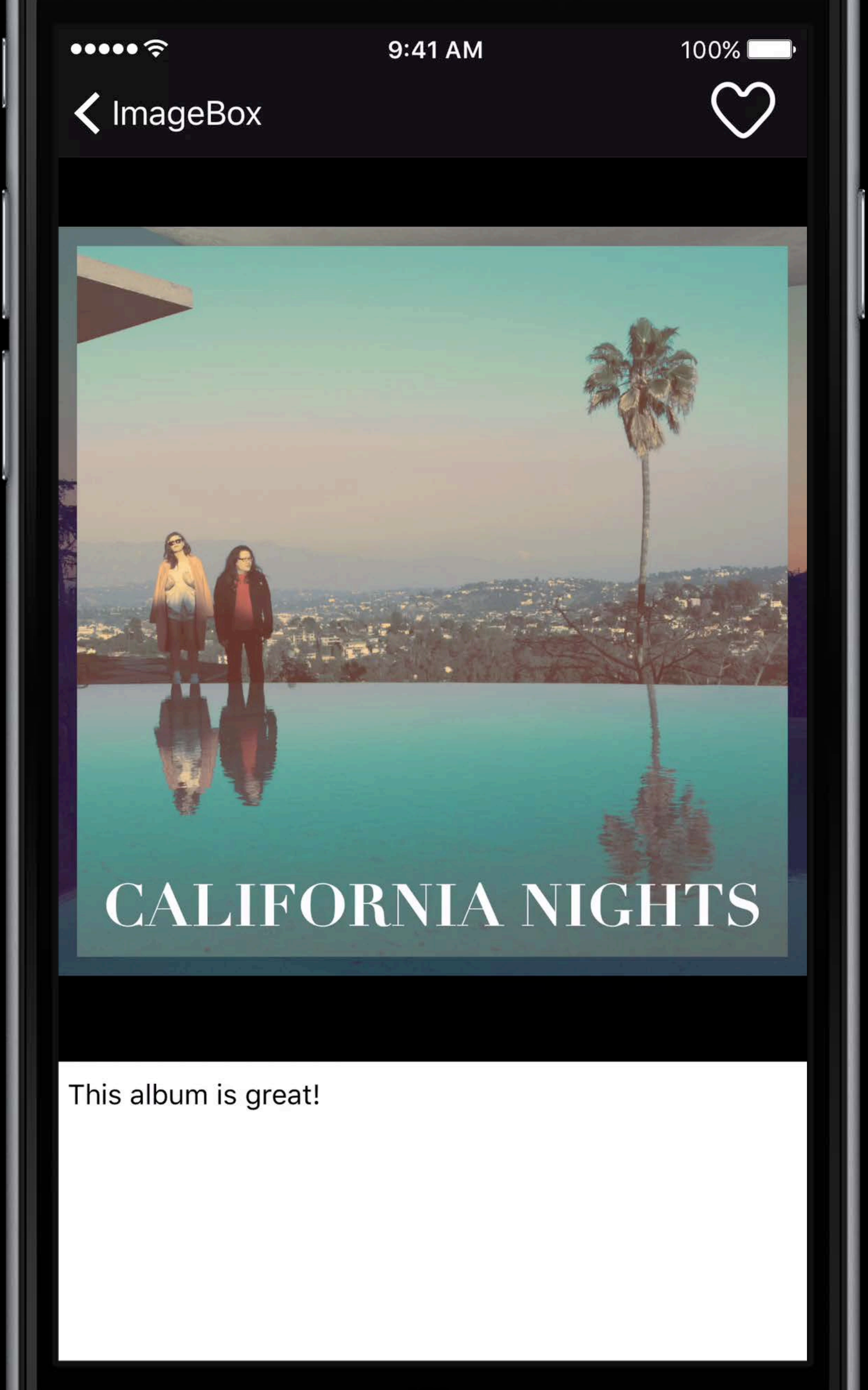


This album is great!



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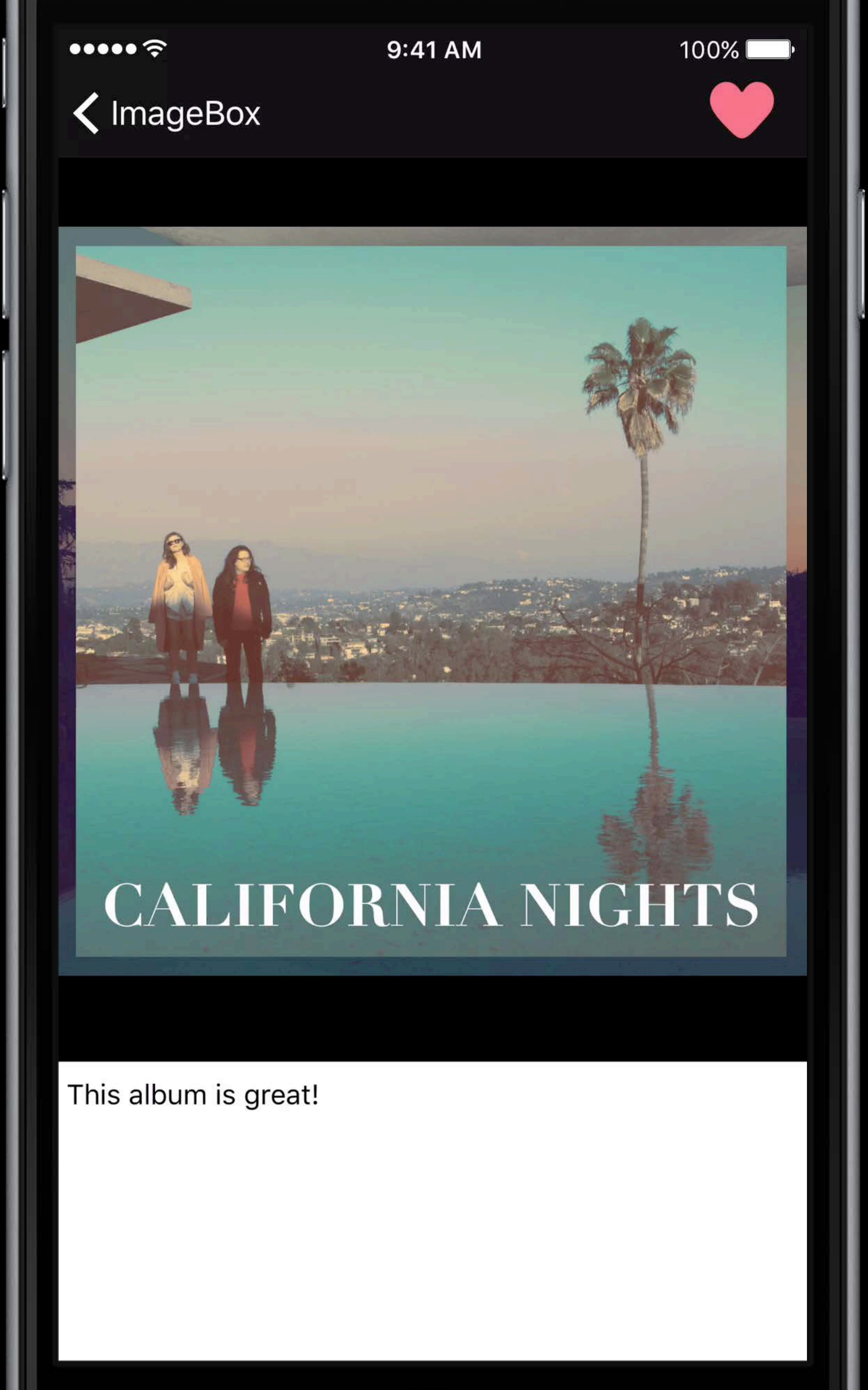

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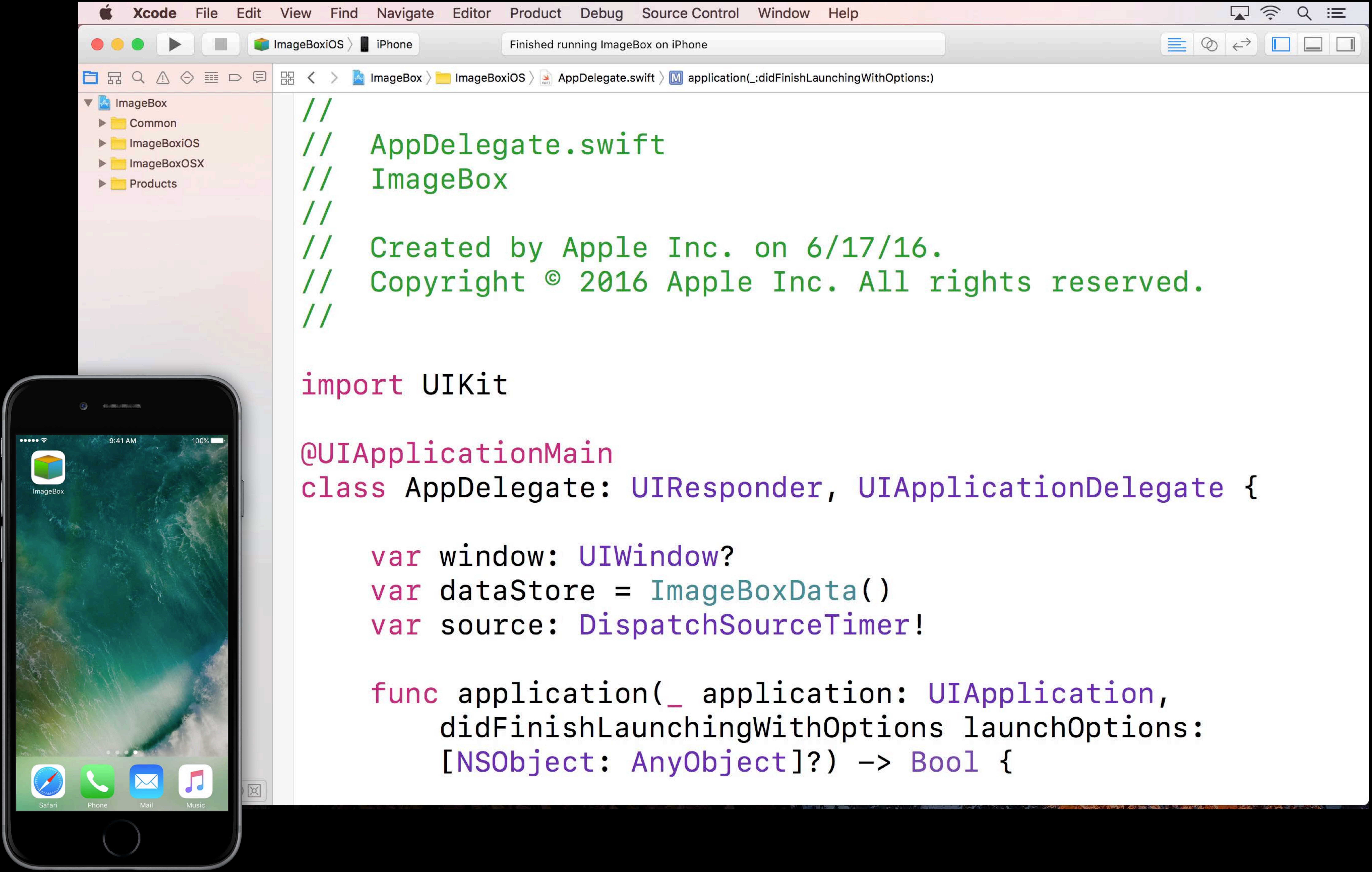

```
//
//  AppDelegate.swift
//  ImageBox
//
//  Created by Apple Inc. on 6/17/16.
//  Copyright © 2016 Apple Inc. All rights reserved.
//

import UIKit

@UIApplicationMain
class AppDelegate: UIResponder, UIApplicationDelegate {

    var window: UIWindow?
    var dataStore = ImageBoxData()
    var source: DispatchSourceTimer!

    func application(_ application: UIApplication,
        didFinishLaunchingWithOptions launchOptions:
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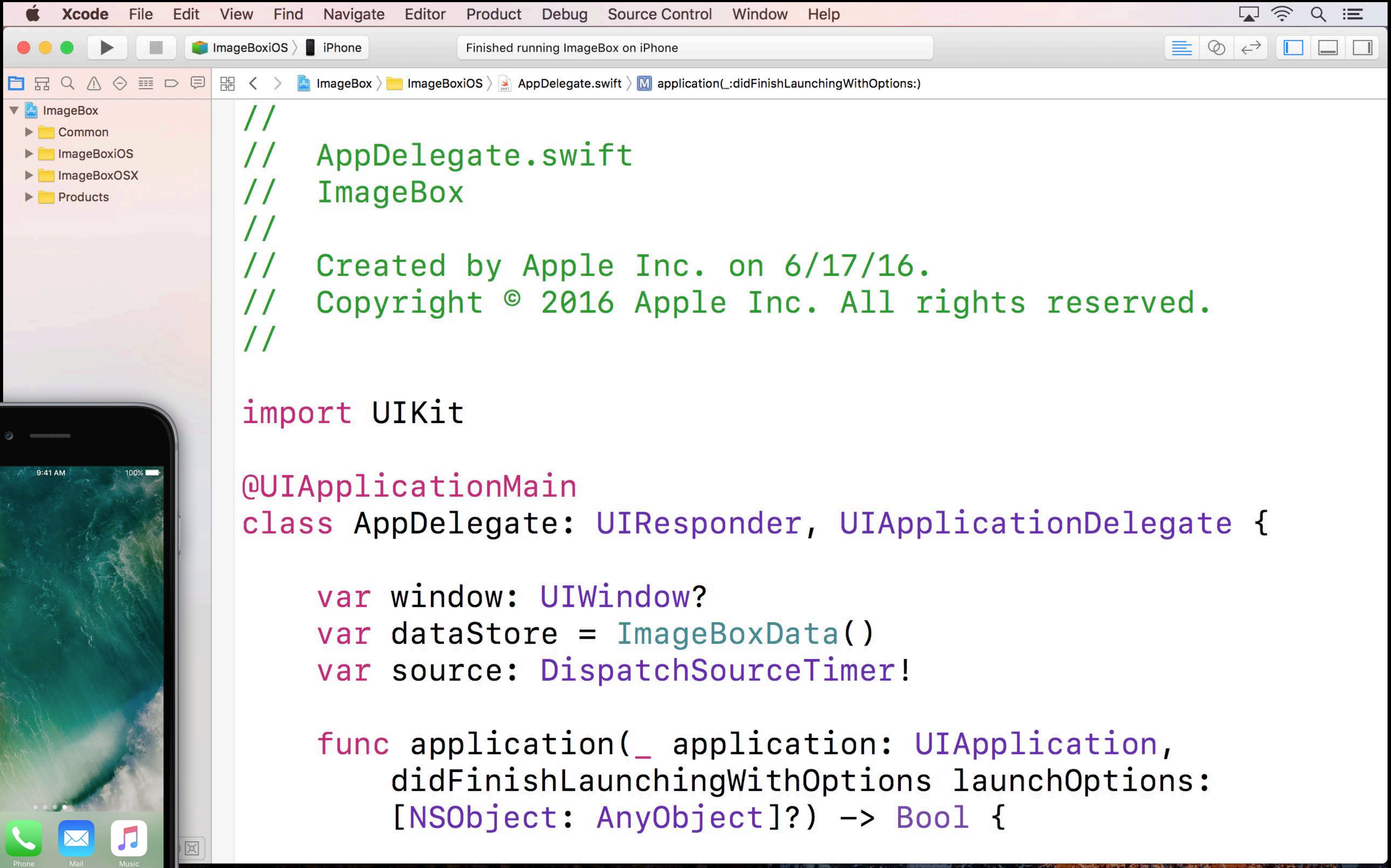
Xcode File Edit View Find Navigate Editor Product Debug Source Control Window Help
ImageBoxiOS iPhone
Finished running ImageBox on iPhone
ImageBox › ImageBoxiOS › AppDelegate.swift › application(_:didFinishLaunchingWithOptions:)
ImageBox
Common
ImageBoxiOS
ImageBoxOSX
Products

```swift
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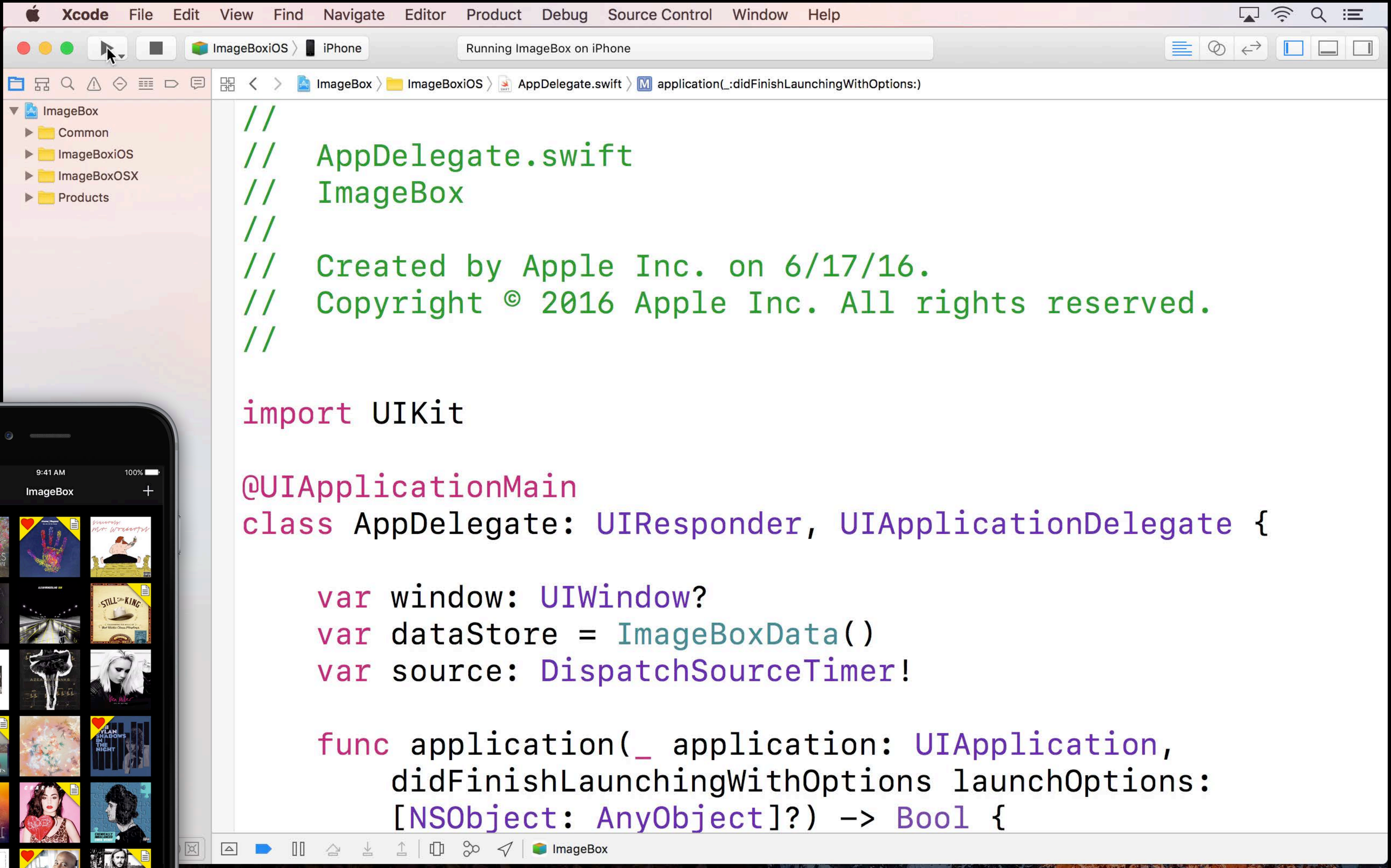

Xcode File Edit View Find Navigate Editor Product Debug Source Control Window Help
ImageBoxiOS 〉 iPhone
Running ImageBox on iPhone
ImageBox 〉 ImageBoxiOS 〉 AppDelegate.swift 〉 application(_:didFinishLaunchingWithOptions:)
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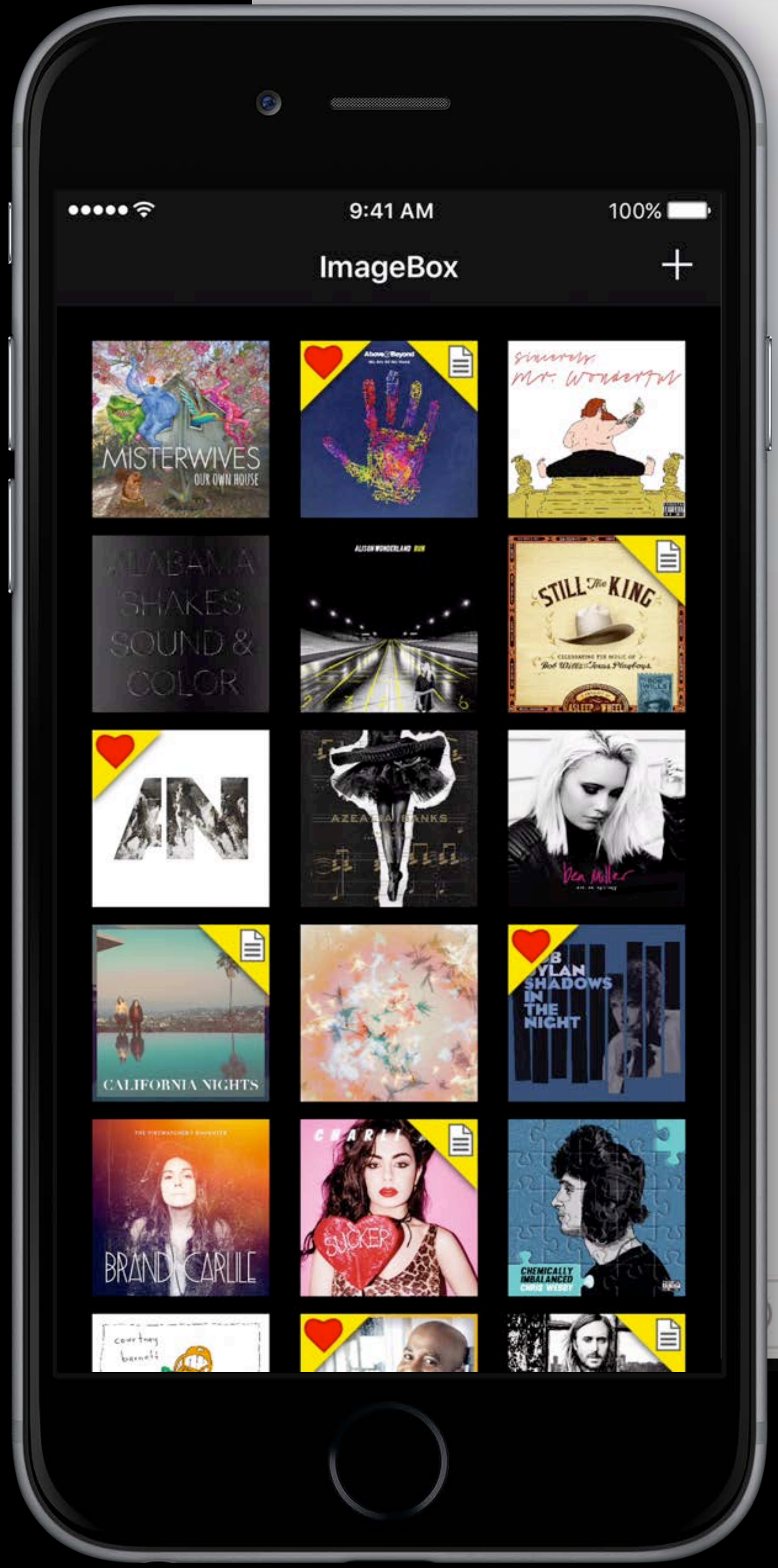

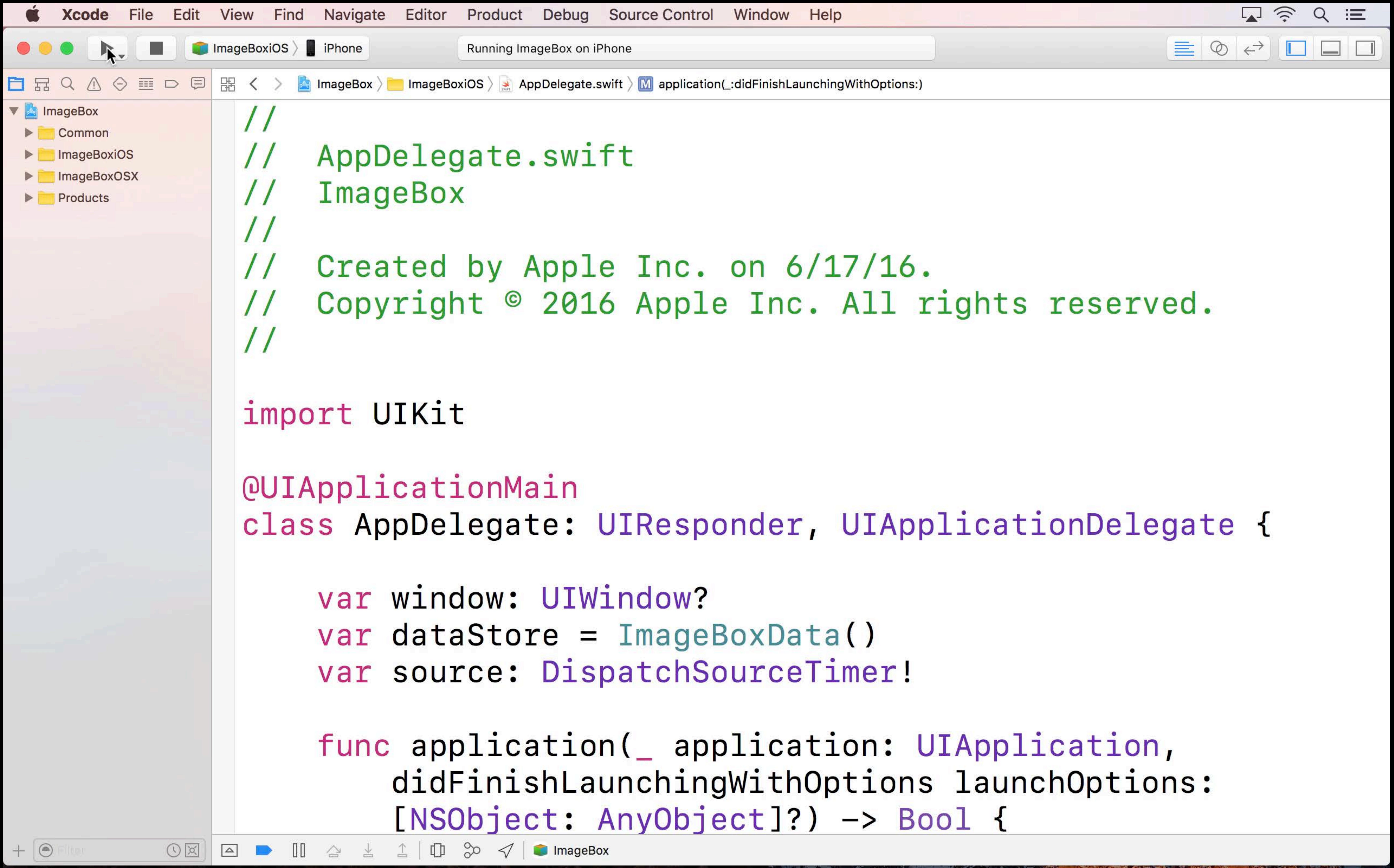
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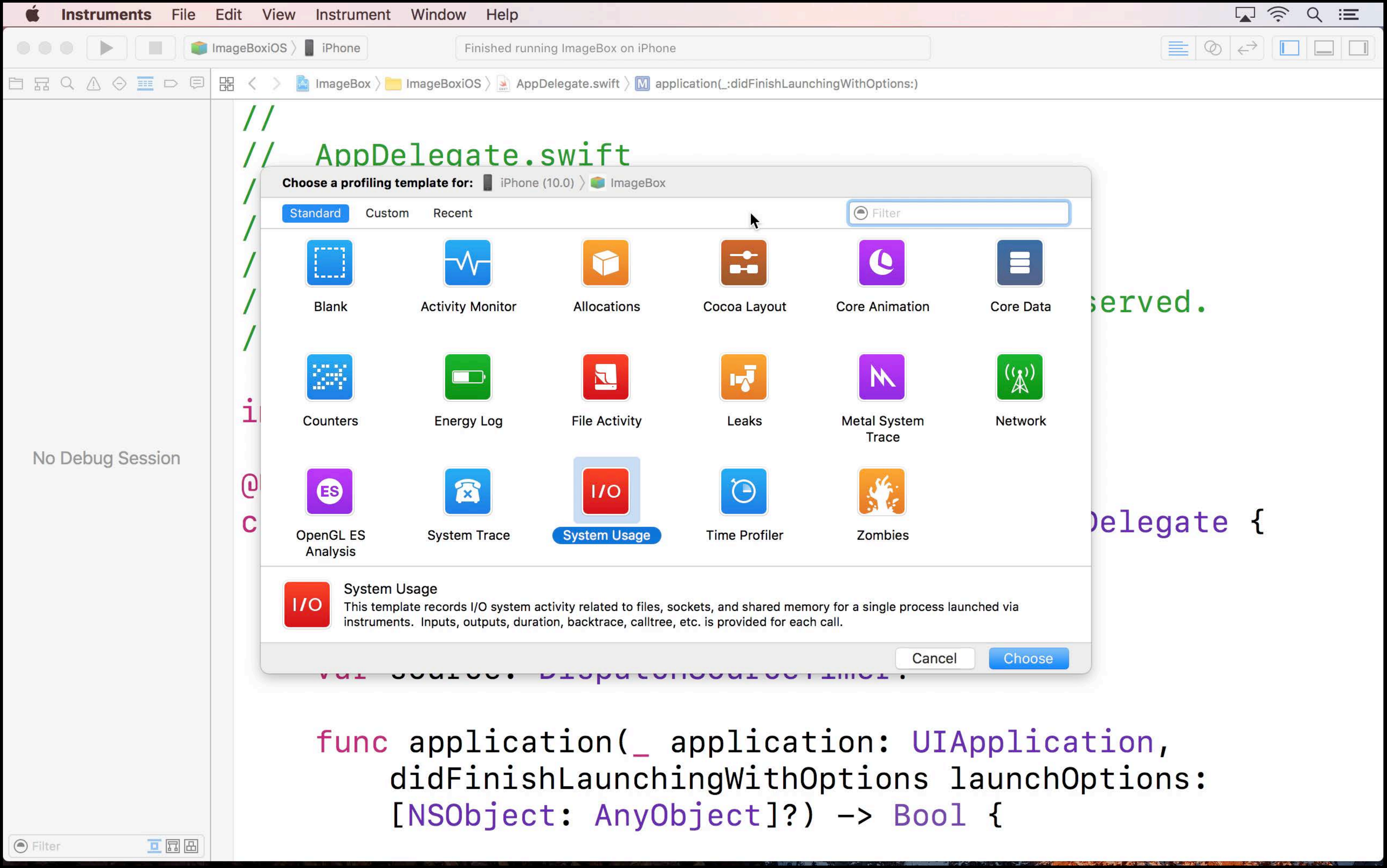

System Usage

This template records I/O system activity related to files, sockets, and shared memory for a single process launched via instruments. Inputs, outputs, duration, backtrace, calltree, etc. is provided for each call.

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i

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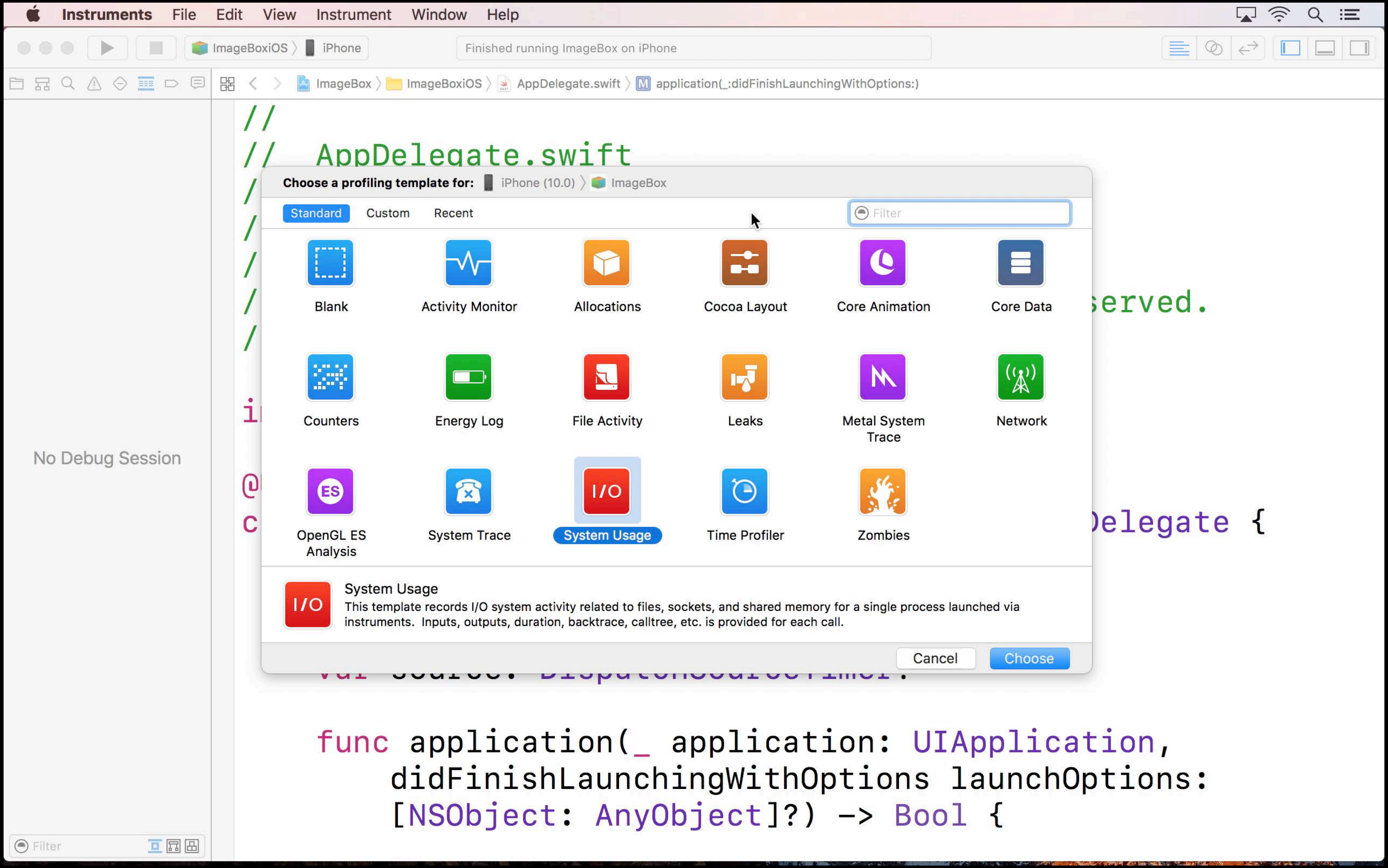

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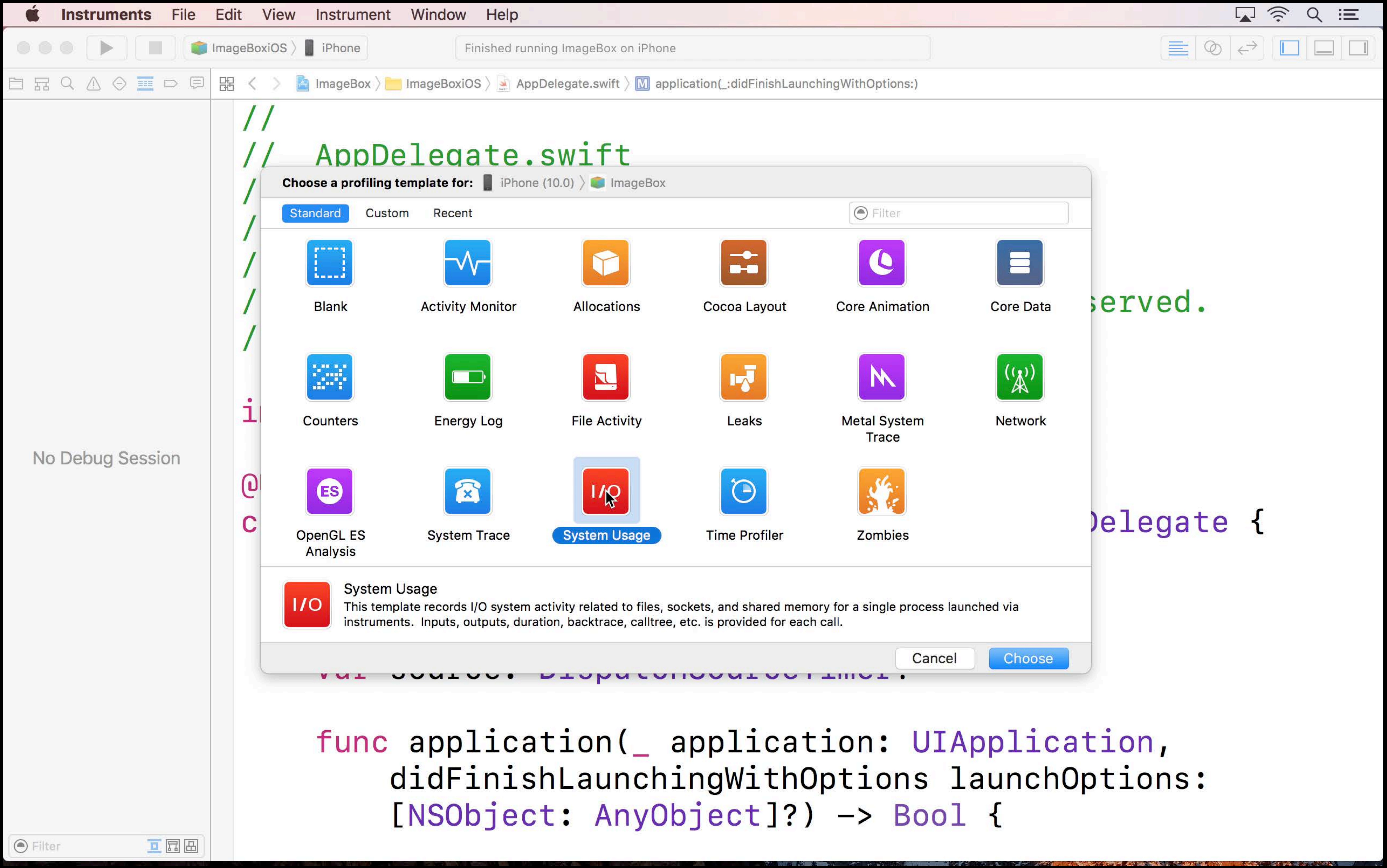

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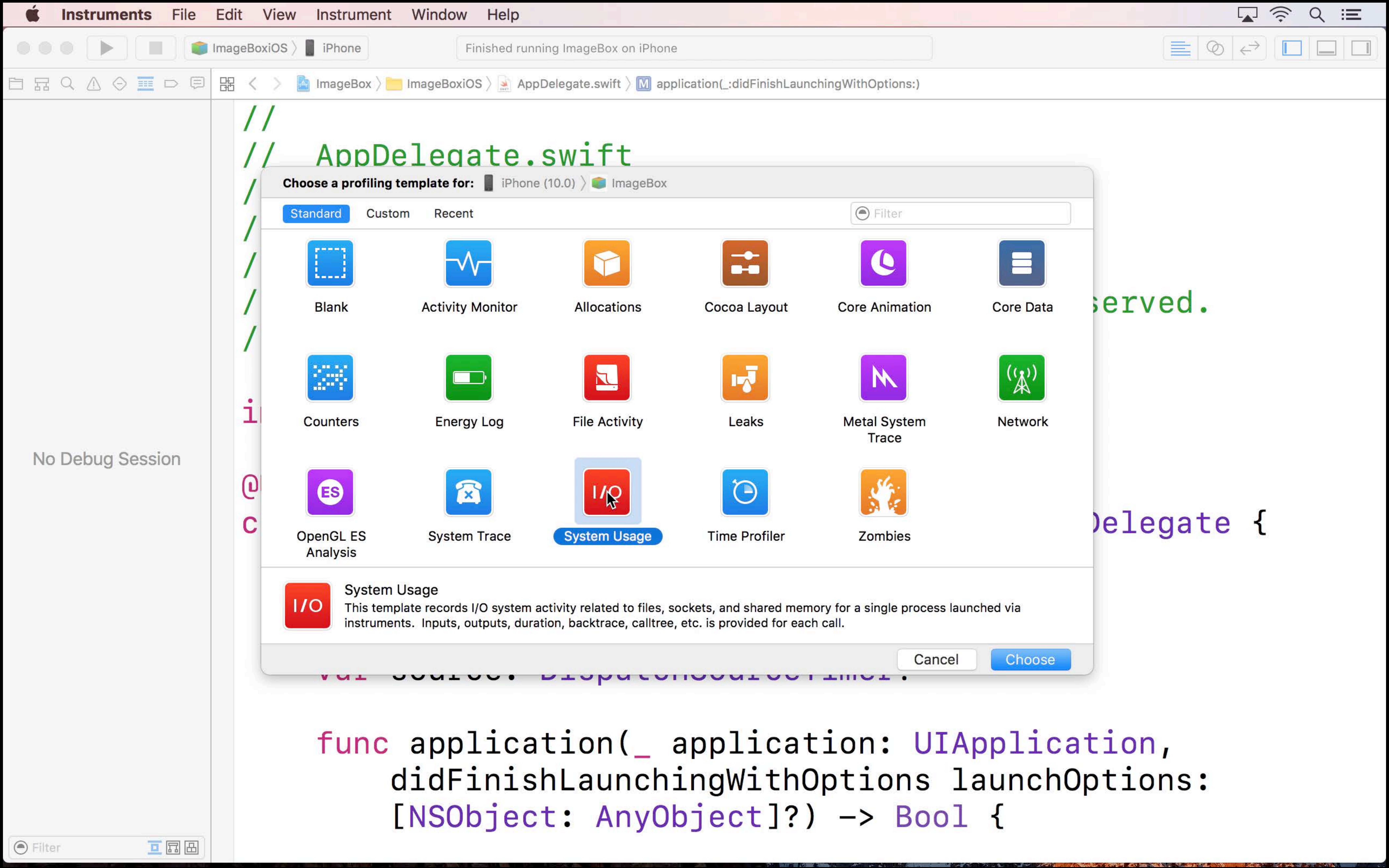

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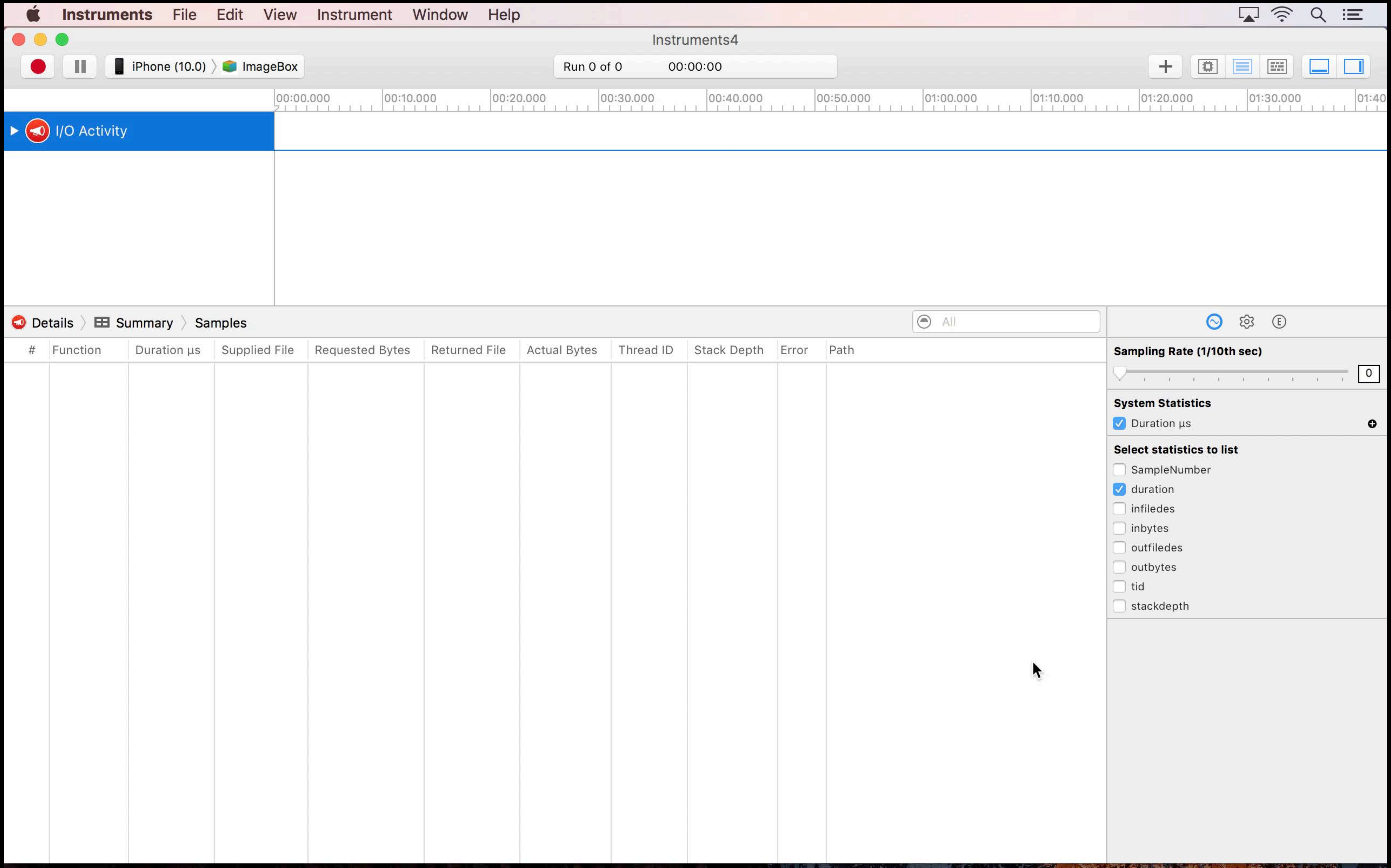


#	Function	Duration µs	Supplied File	Requested Bytes	Returned File	Actual Bytes	Thread ID	Stack Depth	Error	Path

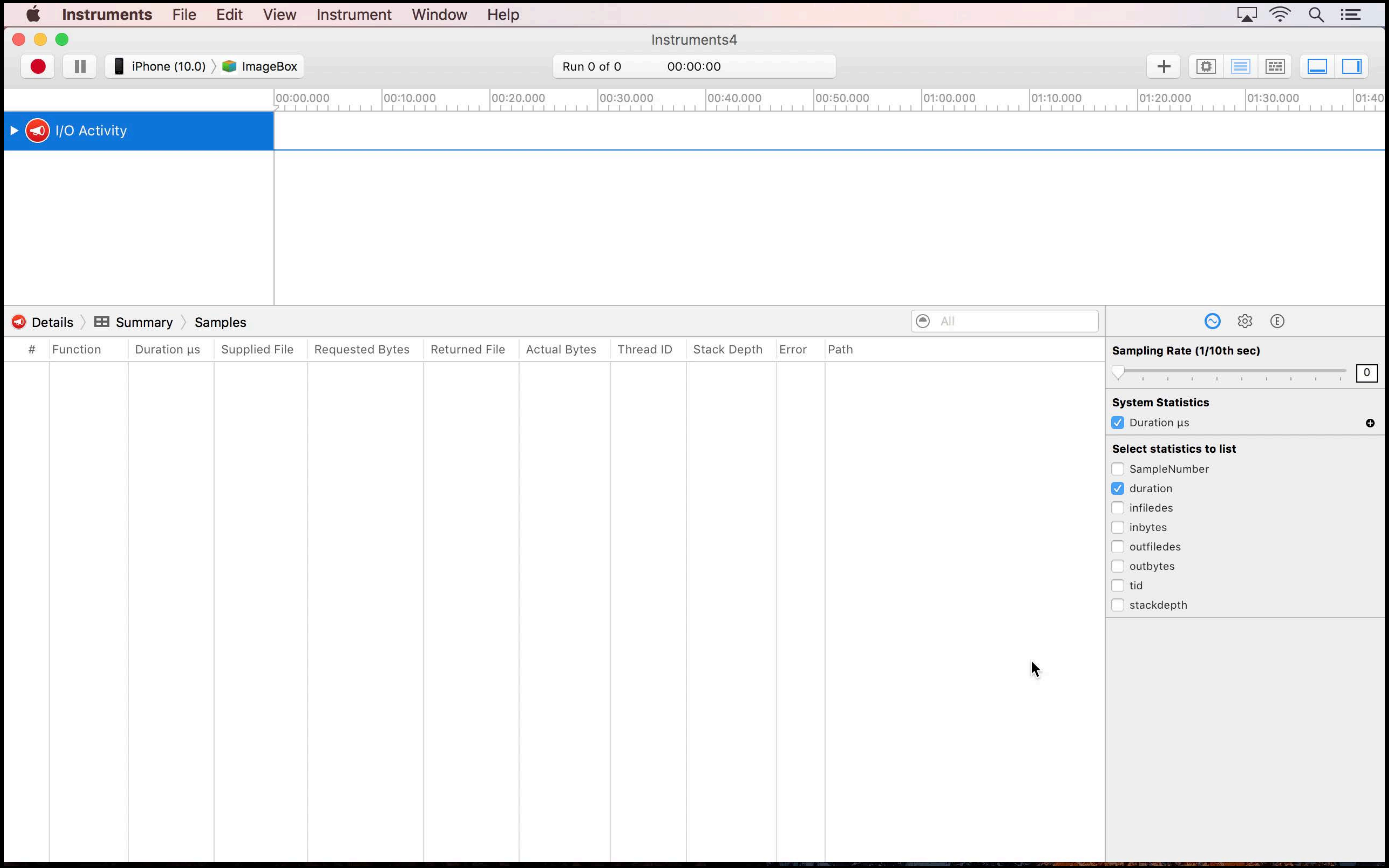
Sampling Rate (1/10th sec) 0

System Statistics

- [✓] Duration µs

Select statistics to list

- [ ] SampleNumber
- [✓] duration
- [ ] infiledes
- [ ] inbytes
- [ ] outfiledes
- [ ] outbytes
- [ ] tid
- [ ] stackdepth



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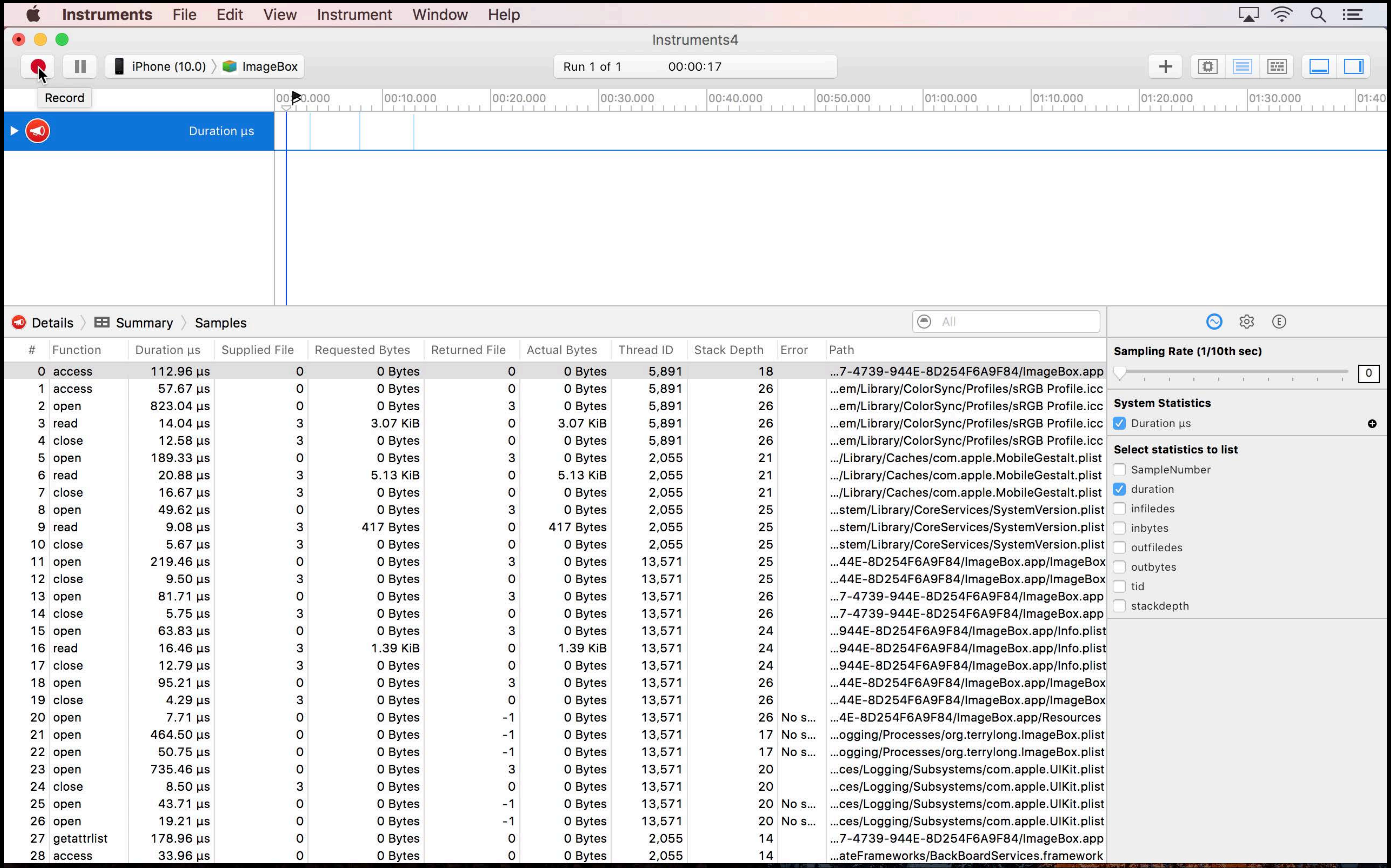


#	Function	Duration µs	Supplied File	Requested Bytes	Returned File	Actual Bytes	Thread ID	Stack Depth	Error	Path
0	access	112.96 µs	0	0 Bytes	0	0 Bytes	5,891	18		...7-4739-944E-8D254F6A9F84/ImageBox.app
1	access	57.67 µs	0	0 Bytes	0	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
2	open	823.04 µs	0	0 Bytes	3	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
3	read	14.04 µs	3	3.07 KiB	0	3.07 KiB	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
4	close	12.58 µs	3	0 Bytes	0	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
5	open	189.33 µs	0	0 Bytes	3	0 Bytes	2,055	21		.../Library/Caches/com.apple.MobileGestalt.plist
6	read	20.88 µs	3	5.13 KiB	0	5.13 KiB	2,055	21		.../Library/Caches/com.apple.MobileGestalt.plist
7	close	16.67 µs	3	0 Bytes	0	0 Bytes	2,055	21		.../Library/Caches/com.apple.MobileGestalt.plist
8	open	49.62 µs	0	0 Bytes	3	0 Bytes	2,055	25		...stem/Library/CoreServices/SystemVersion.plist
9	read	9.08 µs	3	417 Bytes	0	417 Bytes	2,055	25		...stem/Library/CoreServices/SystemVersion.plist
10	close	5.67 µs	3	0 Bytes	0	0 Bytes	2,055	25		...stem/Library/CoreServices/SystemVersion.plist
11	open	219.46 µs	0	0 Bytes	3	0 Bytes	13,571	25		...44E-8D254F6A9F84/ImageBox.app/ImageBox
12	close	9.50 µs	3	0 Bytes	0	0 Bytes	13,571	25		...44E-8D254F6A9F84/ImageBox.app/ImageBox
13	open	81.71 µs	0	0 Bytes	3	0 Bytes	13,571	26		...7-4739-944E-8D254F6A9F84/ImageBox.app
14	close	5.75 µs	3	0 Bytes	0	0 Bytes	13,571	26		...7-4739-944E-8D254F6A9F84/ImageBox.app
15	open	63.83 µs	0	0 Bytes	3	0 Bytes	13,571	24		...944E-8D254F6A9F84/ImageBox.app/Info.plist
16	read	16.46 µs	3	1.39 KiB	0	1.39 KiB	13,571	24		...944E-8D254F6A9F84/ImageBox.app/Info.plist
17	close	12.79 µs	3	0 Bytes	0	0 Bytes	13,571	24		...944E-8D254F6A9F84/ImageBox.app/Info.plist
18	open	95.21 µs	0	0 Bytes	3	0 Bytes	13,571	26		...44E-8D254F6A9F84/ImageBox.app/ImageBox
19	close	4.29 µs	3	0 Bytes	0	0 Bytes	13,571	26		...44E-8D254F6A9F84/ImageBox.app/ImageBox
20	open	7.71 µs	0	0 Bytes	-1	0 Bytes	13,571	26	No s...	...4E-8D254F6A9F84/ImageBox.app/Resources
21	open	464.50 µs	0	0 Bytes	-1	0 Bytes	13,571	17	No s...	...ogging/Processes/org.terrylong.ImageBox.plist
22	open	50.75 µs	0	0 Bytes	-1	0 Bytes	13,571	17	No s...	...ogging/Processes/org.terrylong.ImageBox.plist
23	open	735.46 µs	0	0 Bytes	3	0 Bytes	13,571	20		...ces/Logging/Subsystems/com.apple.UIKit.plist
24	close	8.50 µs	3	0 Bytes	0	0 Bytes	13,571	20		...ces/Logging/Subsystems/com.apple.UIKit.plist
25	open	43.71 µs	0	0 Bytes	-1	0 Bytes	13,571	20	No s...	...ces/Logging/Subsystems/com.apple.UIKit.plist
26	open	19.21 µs	0	0 Bytes	-1	0 Bytes	13,571	20	No s...	...ces/Logging/Subsystems/com.apple.UIKit.plist
27	getattrlist	178.96 µs	0	0 Bytes	0	0 Bytes	2,055	14		...7-4739-944E-8D254F6A9F84/ImageBox.app
28	access	33.96 µs	0	0 Bytes	0	0 Bytes	2,055	14		...ateFrameworks/BackBoardServices.framework

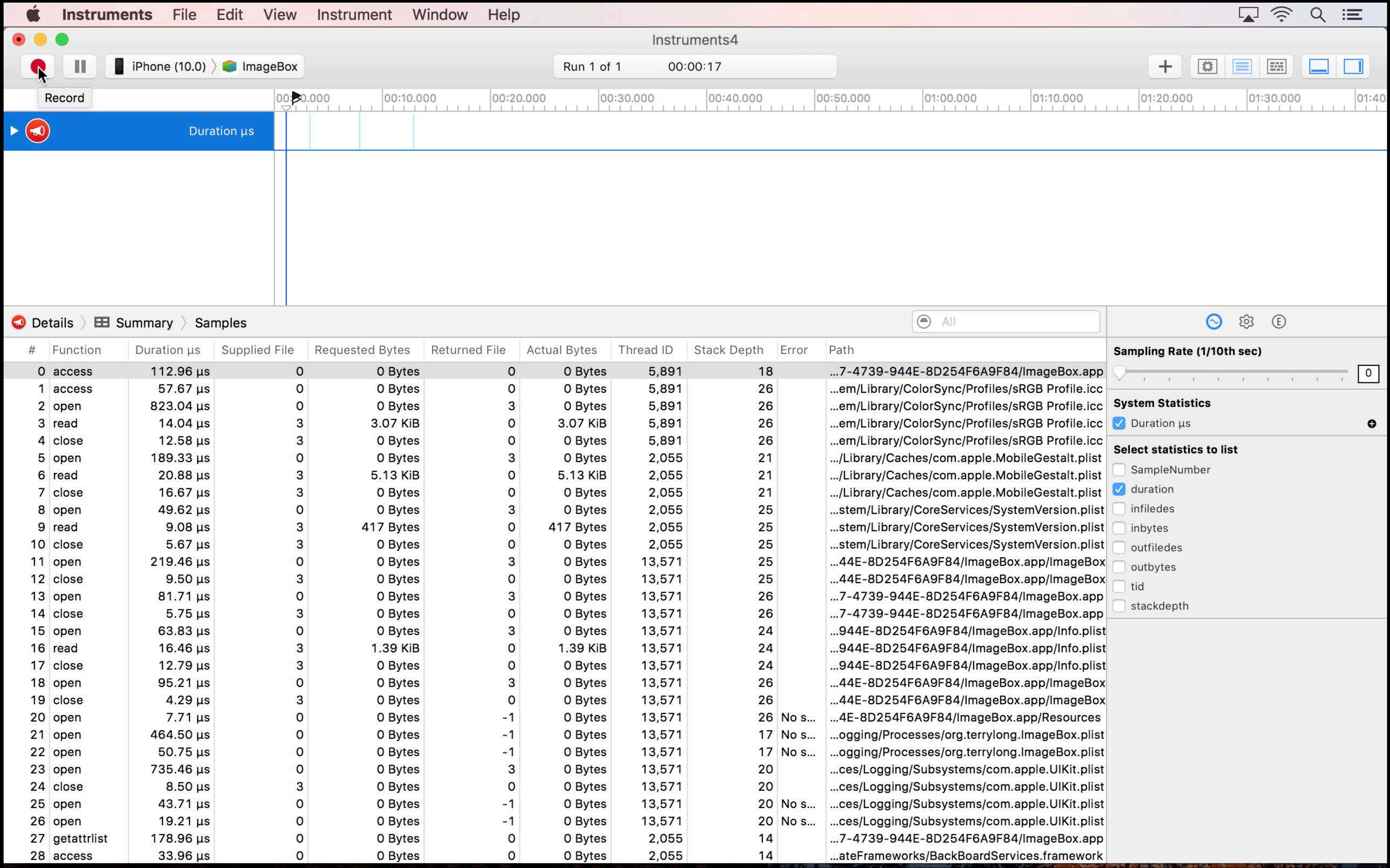
Sampling Rate (1/10th sec) 0

System Statistics

- [✓] Duration µs

Select statistics to list

- [ ] SampleNumber
- [✓] duration
- [ ] infiledes
- [ ] inbytes
- [ ] outfiledes
- [ ] outbytes
- [ ] tid
- [ ] stackdepth



#	Function	Duration µs	Supplied File	Requested Bytes	Returned File	Actual Bytes	Thread ID	Stack Depth	Error	Path
0	access	112.96 µs	0	0 Bytes	0	0 Bytes	5,891	18		...7-4739-944E-8D254F6A9F84/ImageBox.app
1	access	57.67 µs	0	0 Bytes	0	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
2	open	823.04 µs	0	0 Bytes	3	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
3	read	14.04 µs	3	3.07 KiB	0	3.07 KiB	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
4	close	12.58 µs	3	0 Bytes	0	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
5	open	189.33 µs	0	0 Bytes	3	0 Bytes	2,055	21		.../Library/Caches/com.apple.MobileGestalt.plist
6	read	20.88 µs	3	5.13 KiB	0	5.13 KiB	2,055	21		.../Library/Caches/com.apple.MobileGestalt.plist
7	close	16.67 µs	3	0 Bytes	0	0 Bytes	2,055	21		.../Library/Caches/com.apple.MobileGestalt.plist
8	open	49.62 µs	0	0 Bytes	3	0 Bytes	2,055	25		...stem/Library/CoreServices/SystemVersion.plist
9	read	9.08 µs	3	417 Bytes	0	417 Bytes	2,055	25		...stem/Library/CoreServices/SystemVersion.plist
10	close	5.67 µs	3	0 Bytes	0	0 Bytes	2,055	25		...stem/Library/CoreServices/SystemVersion.plist
11	open	219.46 µs	0	0 Bytes	3	0 Bytes	13,571	25		...44E-8D254F6A9F84/ImageBox.app/ImageBox
12	close	9.50 µs	3	0 Bytes	0	0 Bytes	13,571	25		...44E-8D254F6A9F84/ImageBox.app/ImageBox
13	open	81.71 µs	0	0 Bytes	3	0 Bytes	13,571	26		...7-4739-944E-8D254F6A9F84/ImageBox.app
14	close	5.75 µs	3	0 Bytes	0	0 Bytes	13,571	26		...7-4739-944E-8D254F6A9F84/ImageBox.app
15	open	63.83 µs	0	0 Bytes	3	0 Bytes	13,571	24		...944E-8D254F6A9F84/ImageBox.app/Info.plist
16	read	16.46 µs	3	1.39 KiB	0	1.39 KiB	13,571	24		...944E-8D254F6A9F84/ImageBox.app/Info.plist
17	close	12.79 µs	3	0 Bytes	0	0 Bytes	13,571	24		...944E-8D254F6A9F84/ImageBox.app/Info.plist
18	open	95.21 µs	0	0 Bytes	3	0 Bytes	13,571	26		...44E-8D254F6A9F84/ImageBox.app/ImageBox
19	close	4.29 µs	3	0 Bytes	0	0 Bytes	13,571	26		...44E-8D254F6A9F84/ImageBox.app/ImageBox
20	open	7.71 µs	0	0 Bytes	-1	0 Bytes	13,571	26	No s...	...4E-8D254F6A9F84/ImageBox.app/Resources
21	open	464.50 µs	0	0 Bytes	-1	0 Bytes	13,571	17	No s...	...ogging/Processes/org.terrylong.ImageBox.plist
22	open	50.75 µs	0	0 Bytes	-1	0 Bytes	13,571	17	No s...	...ogging/Processes/org.terrylong.ImageBox.plist
23	open	735.46 µs	0	0 Bytes	3	0 Bytes	13,571	20		...ces/Logging/Subsystems/com.apple.UIKit.plist
24	close	8.50 µs	3	0 Bytes	0	0 Bytes	13,571	20		...ces/Logging/Subsystems/com.apple.UIKit.plist
25	open	43.71 µs	0	0 Bytes	-1	0 Bytes	13,571	20	No s...	...ces/Logging/Subsystems/com.apple.UIKit.plist
26	open	19.21 µs	0	0 Bytes	-1	0 Bytes	13,571	20	No s...	...ces/Logging/Subsystems/com.apple.UIKit.plist
27	getattrlist	178.96 µs	0	0 Bytes	0	0 Bytes	2,055	14		...7-4739-944E-8D254F6A9F84/ImageBox.app
28	access	33.96 µs	0	0 Bytes	0	0 Bytes	2,055	14		...ateFrameworks/BackBoardServices.framework

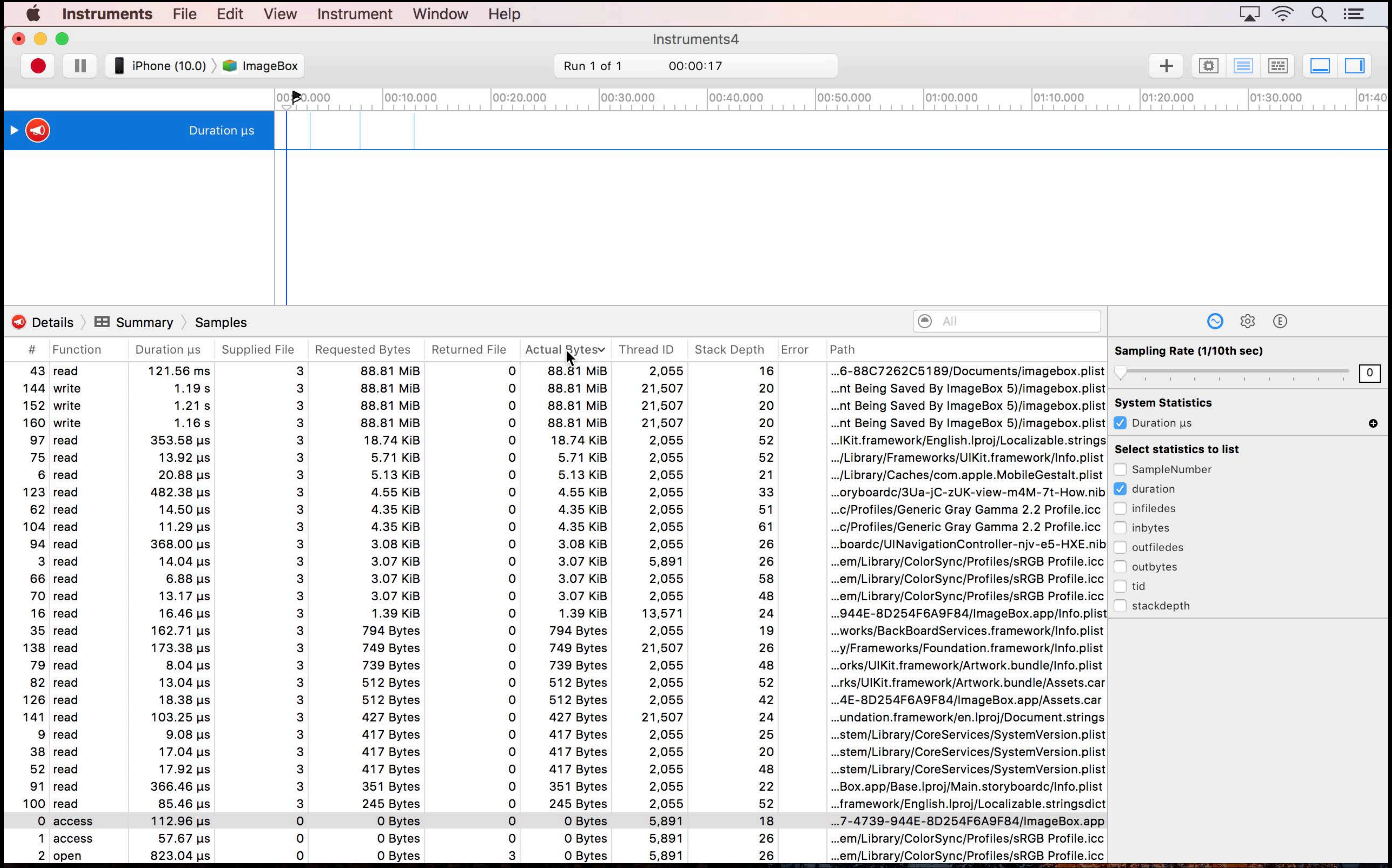
Sampling Rate (1/10th sec) 0

System Statistics

- [✓] Duration µs

Select statistics to list

- [ ] SampleNumber
- [✓] duration
- [ ] infiledes
- [ ] inbytes
- [ ] outfiledes
- [ ] outbytes
- [ ] tid
- [ ] stackdepth



#	Function	Duration µs	Supplied File	Requested Bytes	Returned File	Actual Bytes	Thread ID	Stack Depth	Error	Path
43	read	121.56 ms	3	88.81 MiB	0	88.81 MiB	2,055	16		...6-88C7262C5189/Documents/imagebox.plist
144	write	1.19 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
152	write	1.21 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
160	write	1.16 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
97	read	353.58 µs	3	18.74 KiB	0	18.74 KiB	2,055	52		...lKit.framework/English.lproj/Localizable.strings
75	read	13.92 µs	3	5.71 KiB	0	5.71 KiB	2,055	52		.../Library/Frameworks/UIKit.framework/Info.plist
6	read	20.88 µs	3	5.13 KiB	0	5.13 KiB	2,055	21		.../Library/Caches/com.apple.MobileGestalt.plist
123	read	482.38 µs	3	4.55 KiB	0	4.55 KiB	2,055	33		...oryboardc/3Ua-jC-zUK-view-m4M-7t-How.nib
62	read	14.50 µs	3	4.35 KiB	0	4.35 KiB	2,055	51		...c/Profiles/Generic Gray Gamma 2.2 Profile.icc
104	read	11.29 µs	3	4.35 KiB	0	4.35 KiB	2,055	61		...c/Profiles/Generic Gray Gamma 2.2 Profile.icc
94	read	368.00 µs	3	3.08 KiB	0	3.08 KiB	2,055	26		...boardc/UINavigationController-njv-e5-HXE.nib
3	read	14.04 µs	3	3.07 KiB	0	3.07 KiB	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
66	read	6.88 µs	3	3.07 KiB	0	3.07 KiB	2,055	58		...em/Library/ColorSync/Profiles/sRGB Profile.icc
70	read	13.17 µs	3	3.07 KiB	0	3.07 KiB	2,055	48		...em/Library/ColorSync/Profiles/sRGB Profile.icc
16	read	16.46 µs	3	1.39 KiB	0	1.39 KiB	13,571	24		...944E-8D254F6A9F84/ImageBox.app/Info.plist
35	read	162.71 µs	3	794 Bytes	0	794 Bytes	2,055	19		...works/BackBoardServices.framework/Info.plist
138	read	173.38 µs	3	749 Bytes	0	749 Bytes	21,507	26		...y/Frameworks/Foundation.framework/Info.plist
79	read	8.04 µs	3	739 Bytes	0	739 Bytes	2,055	48		...orks/UIKit.framework/Artwork.bundle/Info.plist
82	read	13.04 µs	3	512 Bytes	0	512 Bytes	2,055	52		...rks/UIKit.framework/Artwork.bundle/Assets.car
126	read	18.38 µs	3	512 Bytes	0	512 Bytes	2,055	42		...4E-8D254F6A9F84/ImageBox.app/Assets.car
141	read	103.25 µs	3	427 Bytes	0	427 Bytes	21,507	24		...undation.framework/en.lproj/Document.strings
9	read	9.08 µs	3	417 Bytes	0	417 Bytes	2,055	25		...stem/Library/CoreServices/SystemVersion.plist
38	read	17.04 µs	3	417 Bytes	0	417 Bytes	2,055	20		...stem/Library/CoreServices/SystemVersion.plist
52	read	17.92 µs	3	417 Bytes	0	417 Bytes	2,055	48		...stem/Library/CoreServices/SystemVersion.plist
91	read	366.46 µs	3	351 Bytes	0	351 Bytes	2,055	22		...Box.app/Base.lproj/Main.storyboardc/Info.plist
100	read	85.46 µs	3	245 Bytes	0	245 Bytes	2,055	52		...framework/English.lproj/Localizable.stringsdict
0	access	112.96 µs	0	0 Bytes	0	0 Bytes	5,891	18		...7-4739-944E-8D254F6A9F84/ImageBox.app
1	access	57.67 µs	0	0 Bytes	0	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
2	open	823.04 µs	0	0 Bytes	3	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc

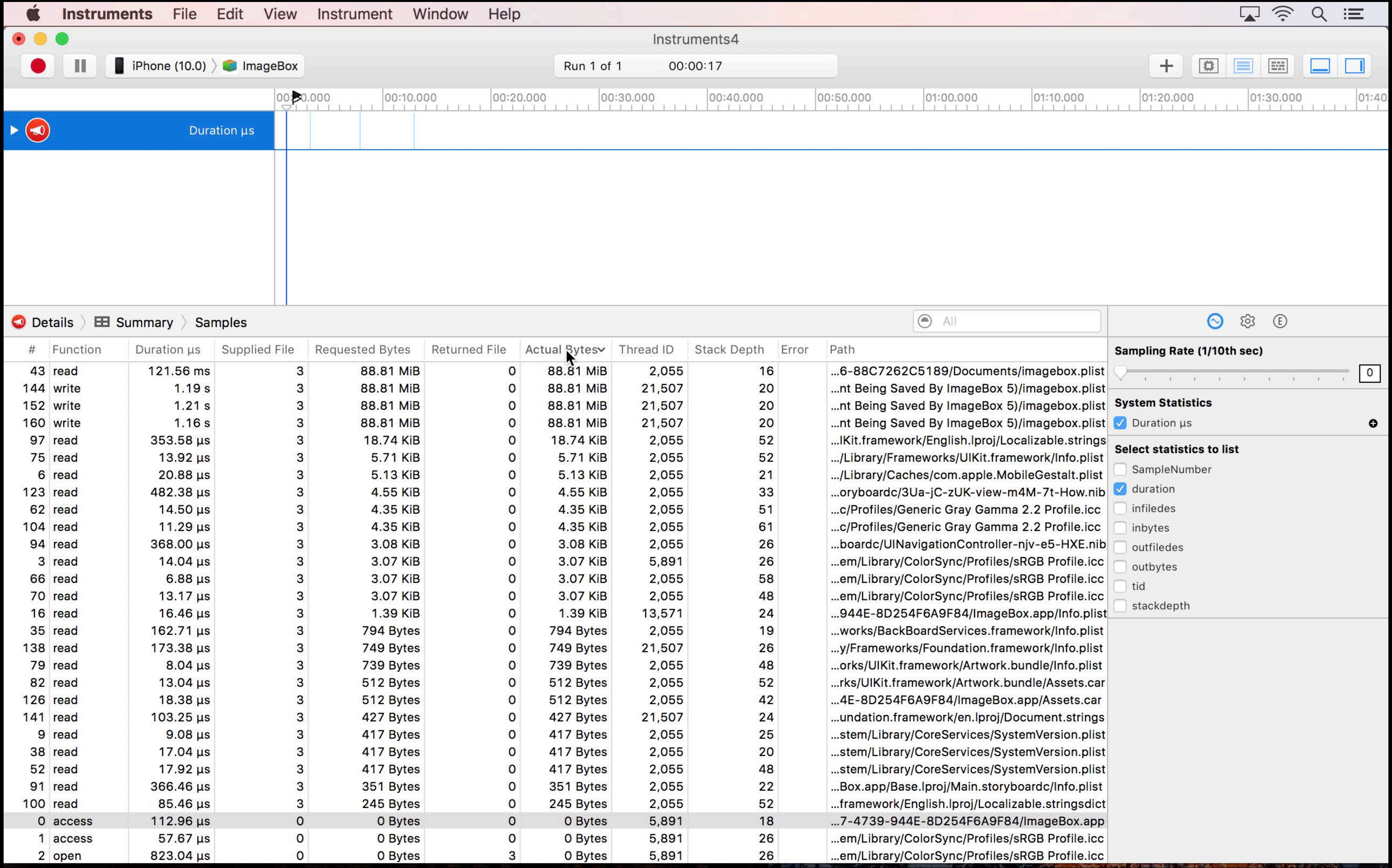
Sampling Rate (1/10th sec) 0

System Statistics

- [✓] Duration µs

Select statistics to list

- [ ] SampleNumber
- [✓] duration
- [ ] infiledes
- [ ] inbytes
- [ ] outfiledes
- [ ] outbytes
- [ ] tid
- [ ] stackdepth



#	Function	Duration µs	Supplied File	Requested Bytes	Returned File	Actual Bytes	Thread ID	Stack Depth	Error	Path
43	read	121.56 ms	3	88.81 MiB	0	88.81 MiB	2,055	16		...6-88C7262C5189/Documents/imagebox.plist
144	write	1.19 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
152	write	1.21 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
160	write	1.16 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
97	read	353.58 µs	3	18.74 KiB	0	18.74 KiB	2,055	52		...lKit.framework/English.lproj/Localizable.strings
75	read	13.92 µs	3	5.71 KiB	0	5.71 KiB	2,055	52		.../Library/Frameworks/UIKit.framework/Info.plist
6	read	20.88 µs	3	5.13 KiB	0	5.13 KiB	2,055	21		.../Library/Caches/com.apple.MobileGestalt.plist
123	read	482.38 µs	3	4.55 KiB	0	4.55 KiB	2,055	33		...oryboardc/3Ua-jC-zUK-view-m4M-7t-How.nib
62	read	14.50 µs	3	4.35 KiB	0	4.35 KiB	2,055	51		...c/Profiles/Generic Gray Gamma 2.2 Profile.icc
104	read	11.29 µs	3	4.35 KiB	0	4.35 KiB	2,055	61		...c/Profiles/Generic Gray Gamma 2.2 Profile.icc
94	read	368.00 µs	3	3.08 KiB	0	3.08 KiB	2,055	26		...boardc/UINavigationController-njv-e5-HXE.nib
3	read	14.04 µs	3	3.07 KiB	0	3.07 KiB	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
66	read	6.88 µs	3	3.07 KiB	0	3.07 KiB	2,055	58		...em/Library/ColorSync/Profiles/sRGB Profile.icc
70	read	13.17 µs	3	3.07 KiB	0	3.07 KiB	2,055	48		...em/Library/ColorSync/Profiles/sRGB Profile.icc
16	read	16.46 µs	3	1.39 KiB	0	1.39 KiB	13,571	24		...944E-8D254F6A9F84/ImageBox.app/Info.plist
35	read	162.71 µs	3	794 Bytes	0	794 Bytes	2,055	19		...works/BackBoardServices.framework/Info.plist
138	read	173.38 µs	3	749 Bytes	0	749 Bytes	21,507	26		...y/Frameworks/Foundation.framework/Info.plist
79	read	8.04 µs	3	739 Bytes	0	739 Bytes	2,055	48		...orks/UIKit.framework/Artwork.bundle/Info.plist
82	read	13.04 µs	3	512 Bytes	0	512 Bytes	2,055	52		...rks/UIKit.framework/Artwork.bundle/Assets.car
126	read	18.38 µs	3	512 Bytes	0	512 Bytes	2,055	42		...4E-8D254F6A9F84/ImageBox.app/Assets.car
141	read	103.25 µs	3	427 Bytes	0	427 Bytes	21,507	24		...undation.framework/en.lproj/Document.strings
9	read	9.08 µs	3	417 Bytes	0	417 Bytes	2,055	25		...stem/Library/CoreServices/SystemVersion.plist
38	read	17.04 µs	3	417 Bytes	0	417 Bytes	2,055	20		...stem/Library/CoreServices/SystemVersion.plist
52	read	17.92 µs	3	417 Bytes	0	417 Bytes	2,055	48		...stem/Library/CoreServices/SystemVersion.plist
91	read	366.46 µs	3	351 Bytes	0	351 Bytes	2,055	22		...Box.app/Base.lproj/Main.storyboardc/Info.plist
100	read	85.46 µs	3	245 Bytes	0	245 Bytes	2,055	52		...framework/English.lproj/Localizable.stringsdict
0	access	112.96 µs	0	0 Bytes	0	0 Bytes	5,891	18		...7-4739-944E-8D254F6A9F84/ImageBox.app
1	access	57.67 µs	0	0 Bytes	0	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
2	open	823.04 µs	0	0 Bytes	3	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc

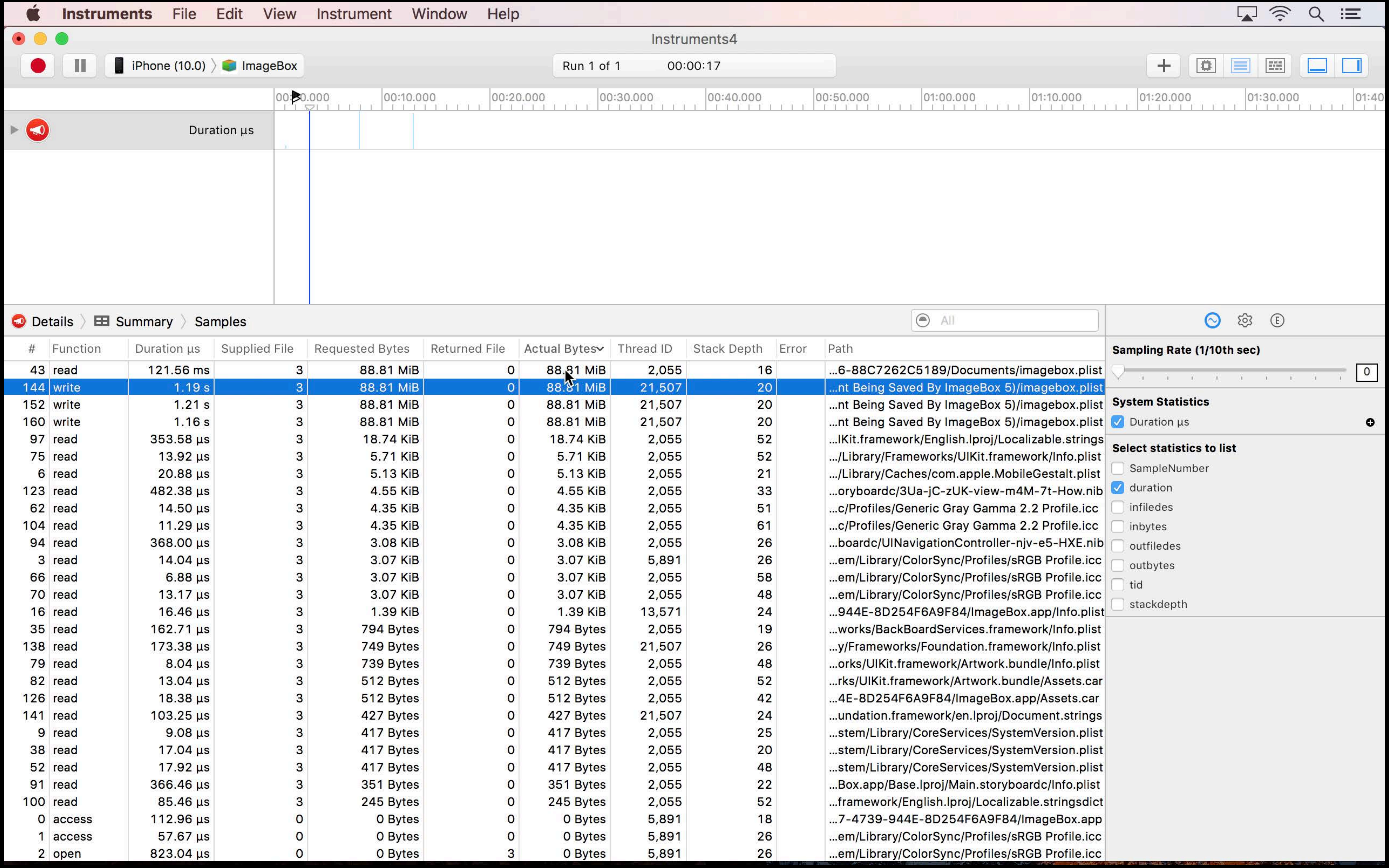
Sampling Rate (1/10th sec) 0

System Statistics

- [✓] Duration µs

Select statistics to list

- [ ] SampleNumber
- [✓] duration
- [ ] infiledes
- [ ] inbytes
- [ ] outfiledes
- [ ] outbytes
- [ ] tid
- [ ] stackdepth



#	Function	Duration µs	Supplied File	Requested Bytes	Returned File	Actual Bytes	Thread ID	Stack Depth	Error	Path
43	read	121.56 ms	3	88.81 MiB	0	88.81 MiB	2,055	16		...6-88C7262C5189/Documents/imagebox.plist
144	write	1.19 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
152	write	1.21 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
160	write	1.16 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
97	read	353.58 µs	3	18.74 KiB	0	18.74 KiB	2,055	52		...IKit.framework/English.lproj/Localizable.strings
75	read	13.92 µs	3	5.71 KiB	0	5.71 KiB	2,055	52		.../Library/Frameworks/UIKit.framework/Info.plist
6	read	20.88 µs	3	5.13 KiB	0	5.13 KiB	2,055	21		.../Library/Caches/com.apple.MobileGestalt.plist
123	read	482.38 µs	3	4.55 KiB	0	4.55 KiB	2,055	33		...oryboardc/3Ua-jC-zUK-view-m4M-7t-How.nib
62	read	14.50 µs	3	4.35 KiB	0	4.35 KiB	2,055	51		...c/Profiles/Generic Gray Gamma 2.2 Profile.icc
104	read	11.29 µs	3	4.35 KiB	0	4.35 KiB	2,055	61		...c/Profiles/Generic Gray Gamma 2.2 Profile.icc
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3	read	14.04 µs	3	3.07 KiB	0	3.07 KiB	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
66	read	6.88 µs	3	3.07 KiB	0	3.07 KiB	2,055	58		...em/Library/ColorSync/Profiles/sRGB Profile.icc
70	read	13.17 µs	3	3.07 KiB	0	3.07 KiB	2,055	48		...em/Library/ColorSync/Profiles/sRGB Profile.icc
16	read	16.46 µs	3	1.39 KiB	0	1.39 KiB	13,571	24		...944E-8D254F6A9F84/ImageBox.app/Info.plist
35	read	162.71 µs	3	794 Bytes	0	794 Bytes	2,055	19		...works/BackBoardServices.framework/Info.plist
138	read	173.38 µs	3	749 Bytes	0	749 Bytes	21,507	26		...y/Frameworks/Foundation.framework/Info.plist
79	read	8.04 µs	3	739 Bytes	0	739 Bytes	2,055	48		...orks/UIKit.framework/Artwork.bundle/Info.plist
82	read	13.04 µs	3	512 Bytes	0	512 Bytes	2,055	52		...rks/UIKit.framework/Artwork.bundle/Assets.car
126	read	18.38 µs	3	512 Bytes	0	512 Bytes	2,055	42		...4E-8D254F6A9F84/ImageBox.app/Assets.car
141	read	103.25 µs	3	427 Bytes	0	427 Bytes	21,507	24		...undation.framework/en.lproj/Document.strings
9	read	9.08 µs	3	417 Bytes	0	417 Bytes	2,055	25		...stem/Library/CoreServices/SystemVersion.plist
38	read	17.04 µs	3	417 Bytes	0	417 Bytes	2,055	20		...stem/Library/CoreServices/SystemVersion.plist
52	read	17.92 µs	3	417 Bytes	0	417 Bytes	2,055	48		...stem/Library/CoreServices/SystemVersion.plist
91	read	366.46 µs	3	351 Bytes	0	351 Bytes	2,055	22		...Box.app/Base.lproj/Main.storyboardc/Info.plist
100	read	85.46 µs	3	245 Bytes	0	245 Bytes	2,055	52		...framework/English.lproj/Localizable.stringsdict
0	access	112.96 µs	0	0 Bytes	0	0 Bytes	5,891	18		...7-4739-944E-8D254F6A9F84/ImageBox.app
1	access	57.67 µs	0	0 Bytes	0	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
2	open	823.04 µs	0	0 Bytes	3	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc

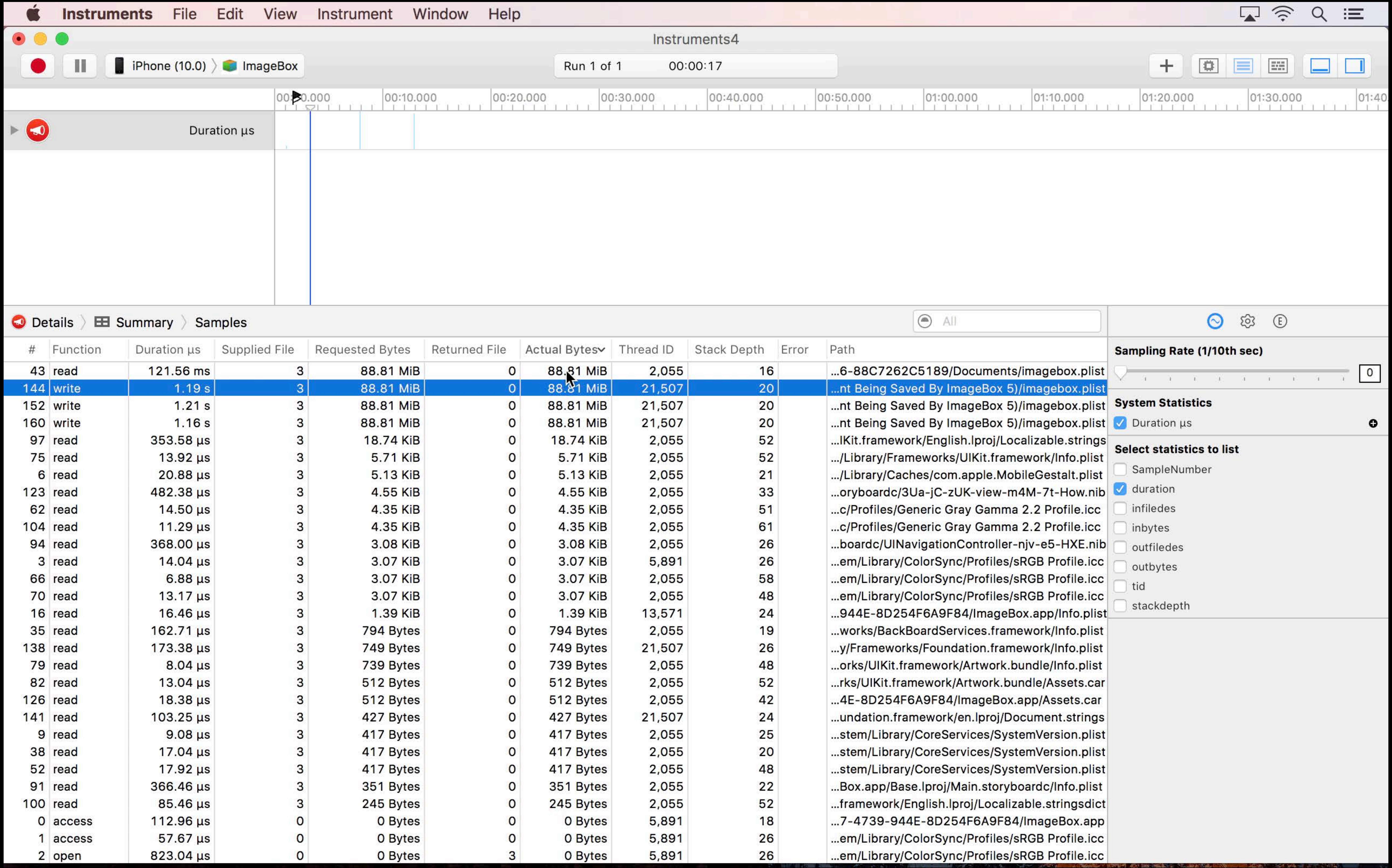
Sampling Rate (1/10th sec) 0

System Statistics

✓ Duration µs

Select statistics to list

- ☐ SampleNumber
- ✓ duration
- ☐ infiledes
- ☐ inbytes
- ☐ outfiledes
- ☐ outbytes
- ☐ tid
- ☐ stackdepth



#	Function	Duration µs	Supplied File	Requested Bytes	Returned File	Actual Bytes	Thread ID	Stack Depth	Error	Path
43	read	121.56 ms	3	88.81 MiB	0	88.81 MiB	2,055	16		...6-88C7262C5189/Documents/imagebox.plist
144	write	1.19 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
152	write	1.21 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
160	write	1.16 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
97	read	353.58 µs	3	18.74 KiB	0	18.74 KiB	2,055	52		...IKit.framework/English.lproj/Localizable.strings
75	read	13.92 µs	3	5.71 KiB	0	5.71 KiB	2,055	52		.../Library/Frameworks/UIKit.framework/Info.plist
6	read	20.88 µs	3	5.13 KiB	0	5.13 KiB	2,055	21		.../Library/Caches/com.apple.MobileGestalt.plist
123	read	482.38 µs	3	4.55 KiB	0	4.55 KiB	2,055	33		...oryboardc/3Ua-jC-zUK-view-m4M-7t-How.nib
62	read	14.50 µs	3	4.35 KiB	0	4.35 KiB	2,055	51		...c/Profiles/Generic Gray Gamma 2.2 Profile.icc
104	read	11.29 µs	3	4.35 KiB	0	4.35 KiB	2,055	61		...c/Profiles/Generic Gray Gamma 2.2 Profile.icc
94	read	368.00 µs	3	3.08 KiB	0	3.08 KiB	2,055	26		...boardc/UINavigationController-njv-e5-HXE.nib
3	read	14.04 µs	3	3.07 KiB	0	3.07 KiB	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
66	read	6.88 µs	3	3.07 KiB	0	3.07 KiB	2,055	58		...em/Library/ColorSync/Profiles/sRGB Profile.icc
70	read	13.17 µs	3	3.07 KiB	0	3.07 KiB	2,055	48		...em/Library/ColorSync/Profiles/sRGB Profile.icc
16	read	16.46 µs	3	1.39 KiB	0	1.39 KiB	13,571	24		...944E-8D254F6A9F84/ImageBox.app/Info.plist
35	read	162.71 µs	3	794 Bytes	0	794 Bytes	2,055	19		...works/BackBoardServices.framework/Info.plist
138	read	173.38 µs	3	749 Bytes	0	749 Bytes	21,507	26		...y/Frameworks/Foundation.framework/Info.plist
79	read	8.04 µs	3	739 Bytes	0	739 Bytes	2,055	48		...orks/UIKit.framework/Artwork.bundle/Info.plist
82	read	13.04 µs	3	512 Bytes	0	512 Bytes	2,055	52		...rks/UIKit.framework/Artwork.bundle/Assets.car
126	read	18.38 µs	3	512 Bytes	0	512 Bytes	2,055	42		...4E-8D254F6A9F84/ImageBox.app/Assets.car
141	read	103.25 µs	3	427 Bytes	0	427 Bytes	21,507	24		...undation.framework/en.lproj/Document.strings
9	read	9.08 µs	3	417 Bytes	0	417 Bytes	2,055	25		...stem/Library/CoreServices/SystemVersion.plist
38	read	17.04 µs	3	417 Bytes	0	417 Bytes	2,055	20		...stem/Library/CoreServices/SystemVersion.plist
52	read	17.92 µs	3	417 Bytes	0	417 Bytes	2,055	48		...stem/Library/CoreServices/SystemVersion.plist
91	read	366.46 µs	3	351 Bytes	0	351 Bytes	2,055	22		...Box.app/Base.lproj/Main.storyboardc/Info.plist
100	read	85.46 µs	3	245 Bytes	0	245 Bytes	2,055	52		...framework/English.lproj/Localizable.stringsdict
0	access	112.96 µs	0	0 Bytes	0	0 Bytes	5,891	18		...7-4739-944E-8D254F6A9F84/ImageBox.app
1	access	57.67 µs	0	0 Bytes	0	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
2	open	823.04 µs	0	0 Bytes	3	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc

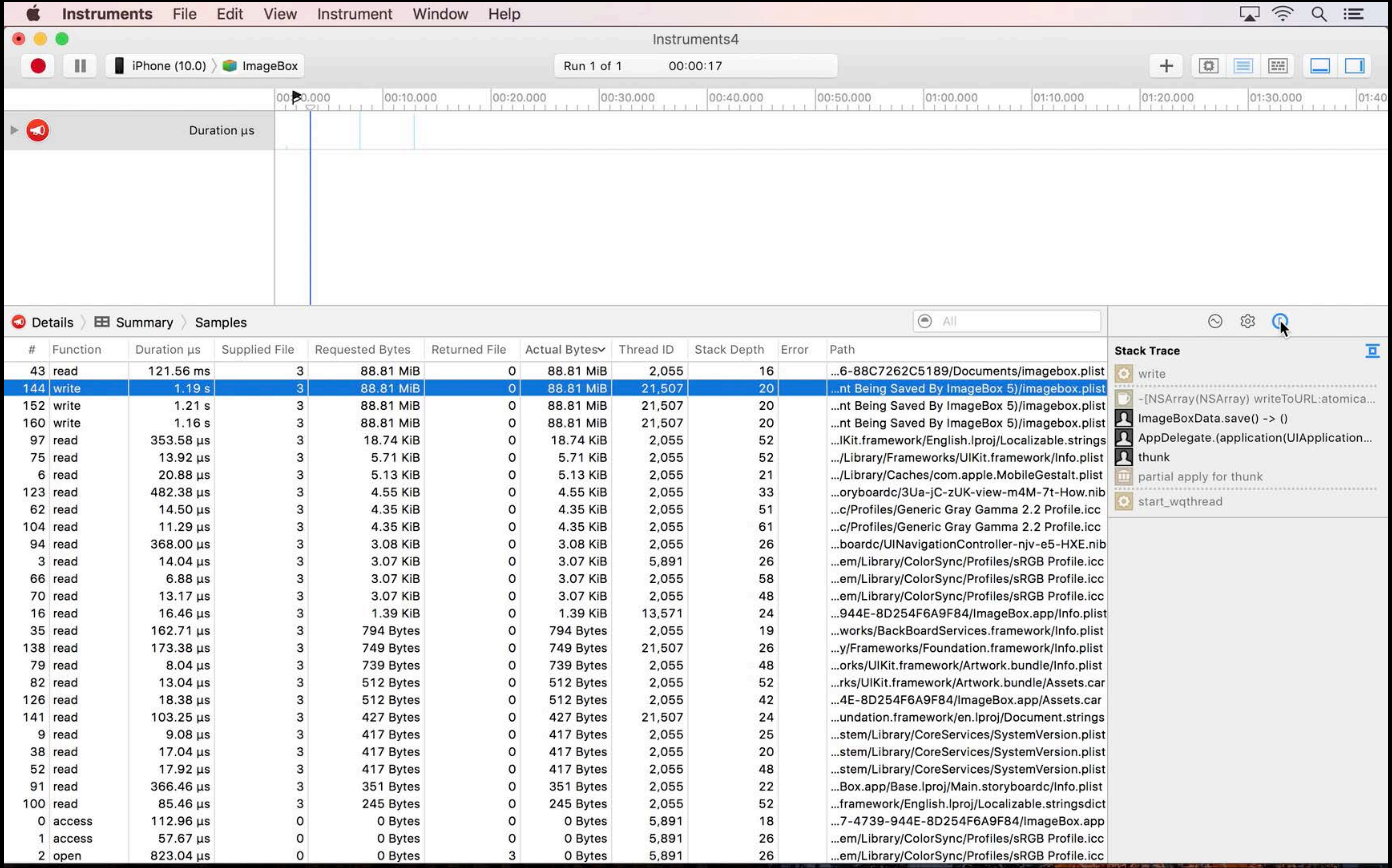
Sampling Rate (1/10th sec) 0

System Statistics

✓ Duration µs

Select statistics to list

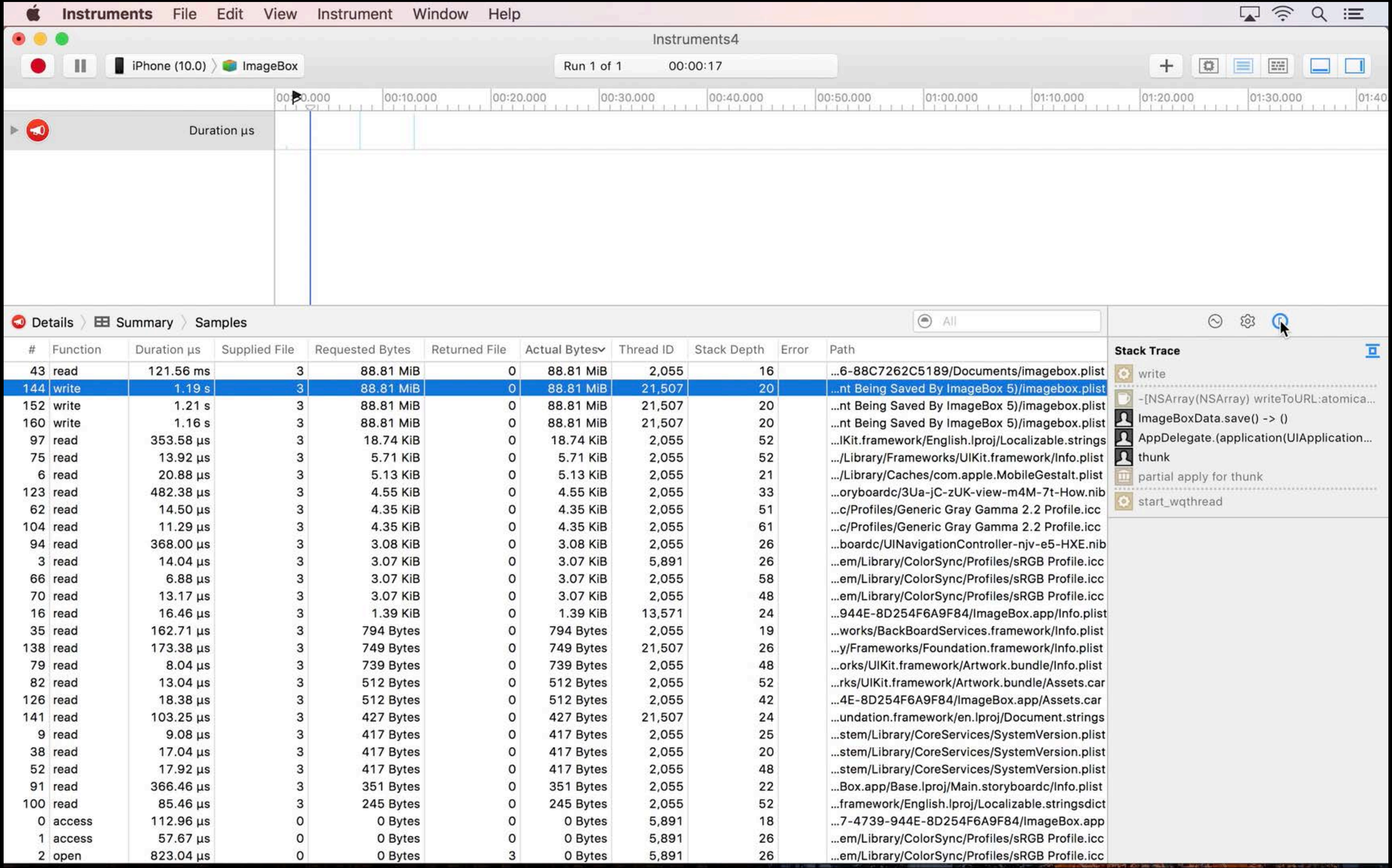
- ☐ SampleNumber
- ✓ duration
- ☐ infiledes
- ☐ inbytes
- ☐ outfiledes
- ☐ outbytes
- ☐ tid
- ☐ stackdepth



#	Function	Duration µs	Supplied File	Requested Bytes	Returned File	Actual Bytes	Thread ID	Stack Depth	Error	Path
43	read	121.56 ms	3	88.81 MiB	0	88.81 MiB	2,055	16		...6-88C7262C5189/Documents/imagebox.plist
144	write	1.19 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
152	write	1.21 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
160	write	1.16 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
97	read	353.58 µs	3	18.74 KiB	0	18.74 KiB	2,055	52		...lKit.framework/English.lproj/Localizable.strings
75	read	13.92 µs	3	5.71 KiB	0	5.71 KiB	2,055	52		.../Library/Frameworks/UIKit.framework/Info.plist
6	read	20.88 µs	3	5.13 KiB	0	5.13 KiB	2,055	21		.../Library/Caches/com.apple.MobileGestalt.plist
123	read	482.38 µs	3	4.55 KiB	0	4.55 KiB	2,055	33		...oryboardc/3Ua-jC-zUK-view-m4M-7t-How.nib
62	read	14.50 µs	3	4.35 KiB	0	4.35 KiB	2,055	51		...c/Profiles/Generic Gray Gamma 2.2 Profile.icc
104	read	11.29 µs	3	4.35 KiB	0	4.35 KiB	2,055	61		...c/Profiles/Generic Gray Gamma 2.2 Profile.icc
94	read	368.00 µs	3	3.08 KiB	0	3.08 KiB	2,055	26		...boardc/UINavigationController-njv-e5-HXE.nib
3	read	14.04 µs	3	3.07 KiB	0	3.07 KiB	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
66	read	6.88 µs	3	3.07 KiB	0	3.07 KiB	2,055	58		...em/Library/ColorSync/Profiles/sRGB Profile.icc
70	read	13.17 µs	3	3.07 KiB	0	3.07 KiB	2,055	48		...em/Library/ColorSync/Profiles/sRGB Profile.icc
16	read	16.46 µs	3	1.39 KiB	0	1.39 KiB	13,571	24		...944E-8D254F6A9F84/ImageBox.app/Info.plist
35	read	162.71 µs	3	794 Bytes	0	794 Bytes	2,055	19		...works/BackBoardServices.framework/Info.plist
138	read	173.38 µs	3	749 Bytes	0	749 Bytes	21,507	26		...y/Frameworks/Foundation.framework/Info.plist
79	read	8.04 µs	3	739 Bytes	0	739 Bytes	2,055	48		...orks/UIKit.framework/Artwork.bundle/Info.plist
82	read	13.04 µs	3	512 Bytes	0	512 Bytes	2,055	52		...rks/UIKit.framework/Artwork.bundle/Assets.car
126	read	18.38 µs	3	512 Bytes	0	512 Bytes	2,055	42		...4E-8D254F6A9F84/ImageBox.app/Assets.car
141	read	103.25 µs	3	427 Bytes	0	427 Bytes	21,507	24		...undation.framework/en.lproj/Document.strings
9	read	9.08 µs	3	417 Bytes	0	417 Bytes	2,055	25		...stem/Library/CoreServices/SystemVersion.plist
38	read	17.04 µs	3	417 Bytes	0	417 Bytes	2,055	20		...stem/Library/CoreServices/SystemVersion.plist
52	read	17.92 µs	3	417 Bytes	0	417 Bytes	2,055	48		...stem/Library/CoreServices/SystemVersion.plist
91	read	366.46 µs	3	351 Bytes	0	351 Bytes	2,055	22		...Box.app/Base.lproj/Main.storyboardc/Info.plist
100	read	85.46 µs	3	245 Bytes	0	245 Bytes	2,055	52		...framework/English.lproj/Localizable.stringsdict
0	access	112.96 µs	0	0 Bytes	0	0 Bytes	5,891	18		...7-4739-944E-8D254F6A9F84/ImageBox.app
1	access	57.67 µs	0	0 Bytes	0	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
2	open	823.04 µs	0	0 Bytes	3	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc

Stack Trace

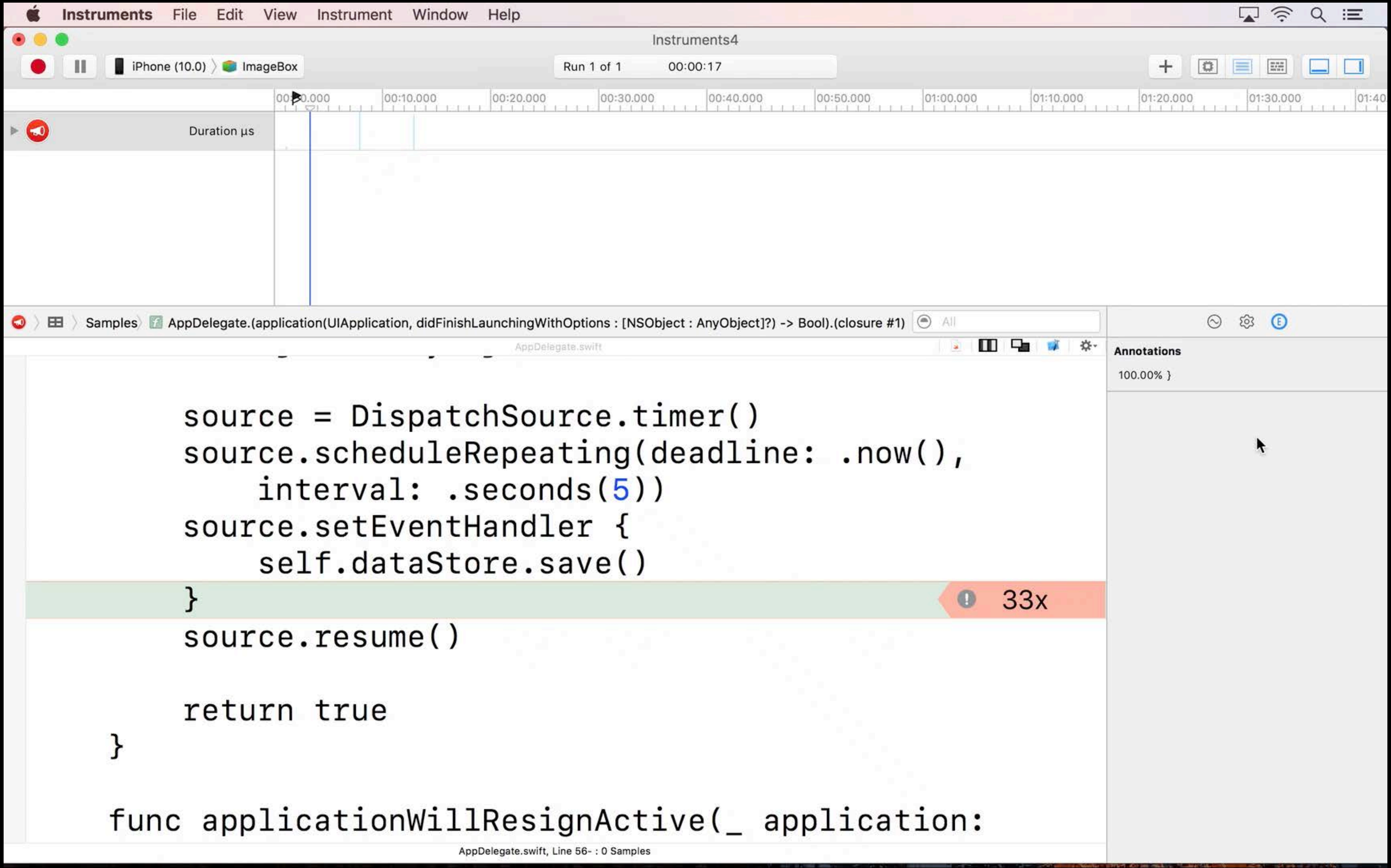
```
write
-[NSArray(NSArray) writeToURL:atomica...
ImageBoxData.save() -> ()
AppDelegate.(application(UIApplication...
thunk
partial apply for thunk
start_wqthread
```



#	Function	Duration µs	Supplied File	Requested Bytes	Returned File	Actual Bytes	Thread ID	Stack Depth	Error	Path
43	read	121.56 ms	3	88.81 MiB	0	88.81 MiB	2,055	16		...6-88C7262C5189/Documents/imagebox.plist
144	write	1.19 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
152	write	1.21 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
160	write	1.16 s	3	88.81 MiB	0	88.81 MiB	21,507	20		...nt Being Saved By ImageBox 5)/imagebox.plist
97	read	353.58 µs	3	18.74 KiB	0	18.74 KiB	2,055	52		...IKit.framework/English.lproj/Localizable.strings
75	read	13.92 µs	3	5.71 KiB	0	5.71 KiB	2,055	52		.../Library/Frameworks/UIKit.framework/Info.plist
6	read	20.88 µs	3	5.13 KiB	0	5.13 KiB	2,055	21		.../Library/Caches/com.apple.MobileGestalt.plist
123	read	482.38 µs	3	4.55 KiB	0	4.55 KiB	2,055	33		...oryboardc/3Ua-jC-zUK-view-m4M-7t-How.nib
62	read	14.50 µs	3	4.35 KiB	0	4.35 KiB	2,055	51		...c/Profiles/Generic Gray Gamma 2.2 Profile.icc
104	read	11.29 µs	3	4.35 KiB	0	4.35 KiB	2,055	61		...c/Profiles/Generic Gray Gamma 2.2 Profile.icc
94	read	368.00 µs	3	3.08 KiB	0	3.08 KiB	2,055	26		...boardc/UINavigationController-njv-e5-HXE.nib
3	read	14.04 µs	3	3.07 KiB	0	3.07 KiB	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
66	read	6.88 µs	3	3.07 KiB	0	3.07 KiB	2,055	58		...em/Library/ColorSync/Profiles/sRGB Profile.icc
70	read	13.17 µs	3	3.07 KiB	0	3.07 KiB	2,055	48		...em/Library/ColorSync/Profiles/sRGB Profile.icc
16	read	16.46 µs	3	1.39 KiB	0	1.39 KiB	13,571	24		...944E-8D254F6A9F84/ImageBox.app/Info.plist
35	read	162.71 µs	3	794 Bytes	0	794 Bytes	2,055	19		...works/BackBoardServices.framework/Info.plist
138	read	173.38 µs	3	749 Bytes	0	749 Bytes	21,507	26		...y/Frameworks/Foundation.framework/Info.plist
79	read	8.04 µs	3	739 Bytes	0	739 Bytes	2,055	48		...orks/UIKit.framework/Artwork.bundle/Info.plist
82	read	13.04 µs	3	512 Bytes	0	512 Bytes	2,055	52		...rks/UIKit.framework/Artwork.bundle/Assets.car
126	read	18.38 µs	3	512 Bytes	0	512 Bytes	2,055	42		...4E-8D254F6A9F84/ImageBox.app/Assets.car
141	read	103.25 µs	3	427 Bytes	0	427 Bytes	21,507	24		...undation.framework/en.lproj/Document.strings
9	read	9.08 µs	3	417 Bytes	0	417 Bytes	2,055	25		...stem/Library/CoreServices/SystemVersion.plist
38	read	17.04 µs	3	417 Bytes	0	417 Bytes	2,055	20		...stem/Library/CoreServices/SystemVersion.plist
52	read	17.92 µs	3	417 Bytes	0	417 Bytes	2,055	48		...stem/Library/CoreServices/SystemVersion.plist
91	read	366.46 µs	3	351 Bytes	0	351 Bytes	2,055	22		...Box.app/Base.lproj/Main.storyboardc/Info.plist
100	read	85.46 µs	3	245 Bytes	0	245 Bytes	2,055	52		...framework/English.lproj/Localizable.stringsdict
0	access	112.96 µs	0	0 Bytes	0	0 Bytes	5,891	18		...7-4739-944E-8D254F6A9F84/ImageBox.app
1	access	57.67 µs	0	0 Bytes	0	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc
2	open	823.04 µs	0	0 Bytes	3	0 Bytes	5,891	26		...em/Library/ColorSync/Profiles/sRGB Profile.icc

Stack Trace

```
write
-[NSArray(NSArray) writeToURL:atomica...
ImageBoxData.save() -> ()
AppDelegate.(application(UIApplication...
thunk
partial apply for thunk
start_wqthread
```



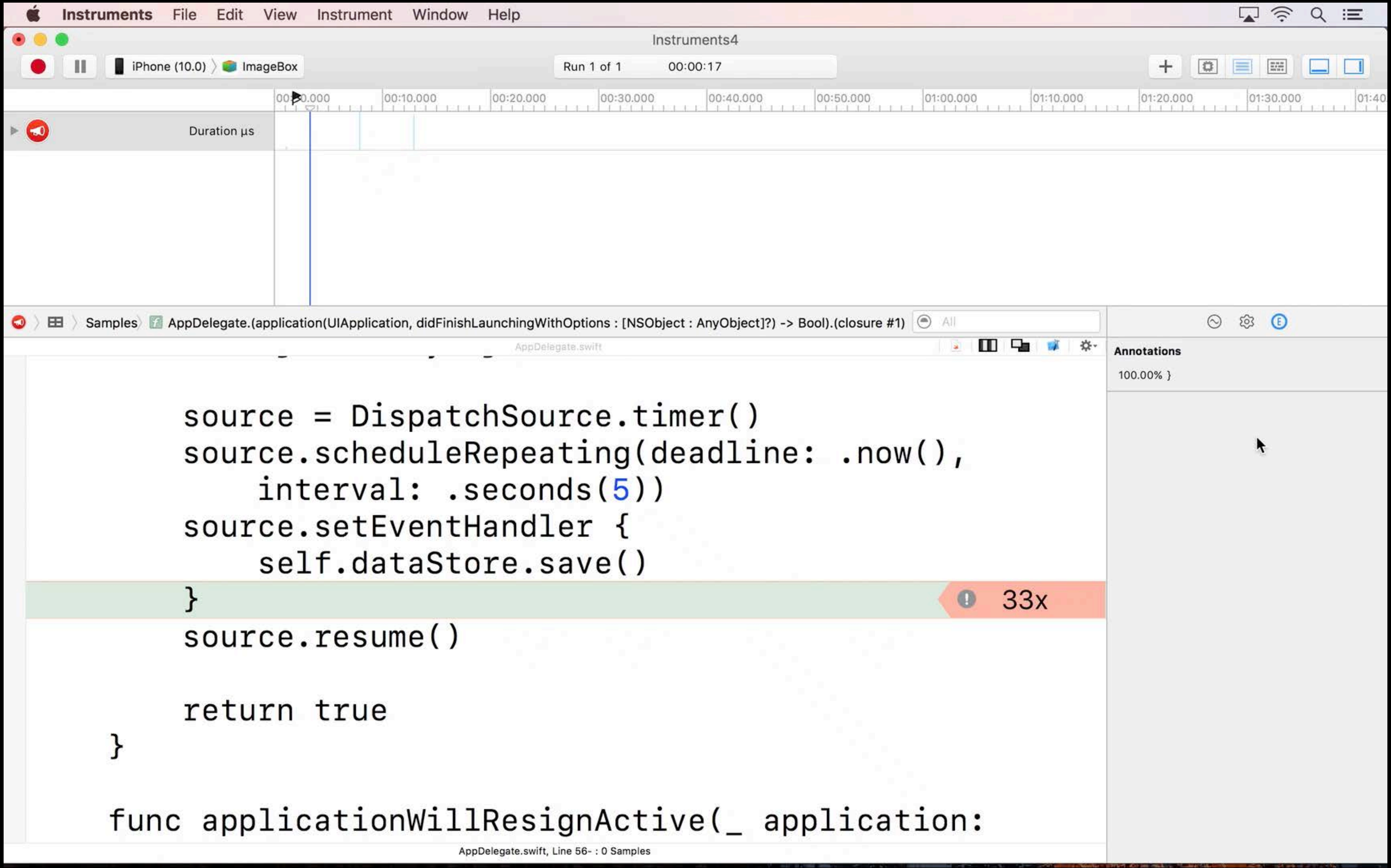
AppDelegate.(application(UIApplication, didFinishLaunchingWithOptions : [NSObject : AnyObject]?) -> Bool).(closure #1)

```
        source = DispatchSource.timer()
        source.scheduleRepeating(deadline: .now(),
            interval: .seconds(5))
        source.setEventHandler {
            self.dataStore.save()
        }
        source.resume()

        return true
    }

    func applicationWillResignActive(_ application:
```

AppDelegate.swift, Line 56- : 0 Samples



AppDelegate.(application(UIApplication, didFinishLaunchingWithOptions : [NSObject : AnyObject]?) -> Bool).(closure #1)

```
        source = DispatchSource.timer()
        source.scheduleRepeating(deadline: .now(),
            interval: .seconds(5))
        source.setEventHandler {
            self.dataStore.save()
        }                                                33x
        source.resume()

        return true
    }

    func applicationWillResignActive(_ application:
```

AppDelegate.swift, Line 56- : 0 Samples

Frequent Writes

```swift
class ImageBoxData {…}
class AppDelegate: UIResponder, UIApplicationDelegate {
   let dataStore = ImageBoxData()
   var source: DispatchSourceTimer!
   func application(_ application: UIApplication, didFinishLaunchingWithOptions launchOptions:
      [NSObject: AnyObject]?) -> Bool {
      source = DispatchSource.timer()
      source.scheduleRepeating(deadline: .now(), interval: .seconds(5))
      source.setEventHandler {
         self.dataStore.save()
      }
      source.activate()
   }
}
```

Frequent Writes

```
class ImageBoxData {…}
class AppDelegate: UIResponder, UIApplicationDelegate {
   let dataStore = ImageBoxData()
   var source: DispatchSourceTimer!
   func application(_ application: UIApplication, didFinishLaunchingWithOptions launchOptions:
      [NSObject: AnyObject]?) -> Bool {
      source = DispatchSource.timer()
      source.scheduleRepeating(deadline: .now(), interval: .seconds(5))
      source.setEventHandler {
         self.dataStore.save()
      }
      source.activate()
   }
}
```

Frequent Writes

```
class ImageBoxData {…}
class AppDelegate: UIResponder, UIApplicationDelegate {
   let dataStore = ImageBoxData()
   var source: DispatchSourceTimer!
   func application(_ application: UIApplication, didFinishLaunchingWithOptions launchOptions:
      [NSObject: AnyObject]?) -> Bool {
      source = DispatchSource.timer()
      source.scheduleRepeating(deadline: .now(), interval: .seconds(5))
      source.setEventHandler {
         self.dataStore.save()
      }
      source.activate()
   }
}
```

Coalescing I/O

```
func application(_ application: UIApplication, didFinishLaunchingWithOptions launchOptions:
    [NSObject: AnyObject]?) -> Bool {
    source = DispatchSource.timer()
    source.scheduleRepeating(deadline: .now(), interval: .seconds(5))
    source.setEventHandler {
        self.dataStore.save()
    }
    source.activate()
}
```

Coalescing I/O

```
func application(_ application: UIApplication, didFinishLaunchingWithOptions launchOptions:
    [NSObject: AnyObject]?) -> Bool {
    source = DispatchSource.timer()
    source.scheduleRepeating(deadline: .now(), interval: .seconds(5))
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        self.dataStore.save()
    }
    source.activate()
}
```

Coalescing I/O

```
func application(_ application: UIApplication, didFinishLaunchingWithOptions launchOptions:
    [NSObject: AnyObject]?) -> Bool {
    source = DispatchSource.timer()
    source.setEventHandler {
        self.dataStore.save()
    }
    source.activate()
}
```

Coalescing I/O

✓

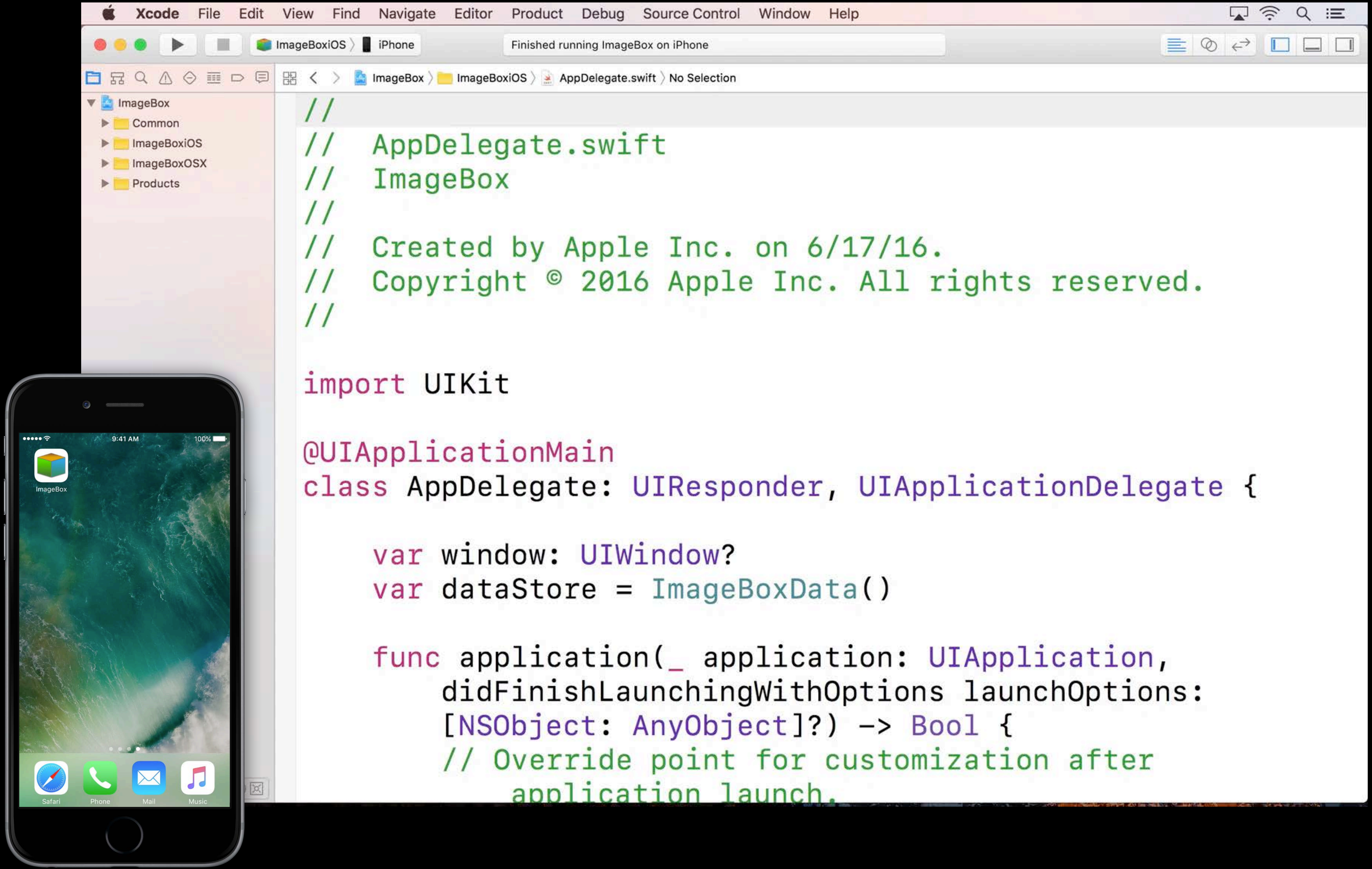
```
func application(_ application: UIApplication, didFinishLaunchingWithOptions launchOptions:
   [NSObject: AnyObject]?) -> Bool {
   source = DispatchSource.timer()
   source.setEventHandler {
      self.dataStore.save()
   }
   source.activate()
}
```

```
// callback for data store changes
func dataStoreDidChange(_ dataStore: ImageBoxData) {
   source.scheduleOneshot(deadline: .now() + .seconds(15), leeway: .seconds(1))
}
```

Coalescing I/O

```
func application(_ application: UIApplication, didFinishLaunchingWithOptions launchOptions:
   [NSObject: AnyObject]?) -> Bool {
   source = DispatchSource.timer()
   source.setEventHandler {
      self.dataStore.save()
   }
   source.activate()
}
```

```
// callback for data store changes
func dataStoreDidChange(_ dataStore: ImageBoxData) {
   source.scheduleOneshot(deadline: .now() + .seconds(15), leeway: .seconds(1))
}
```



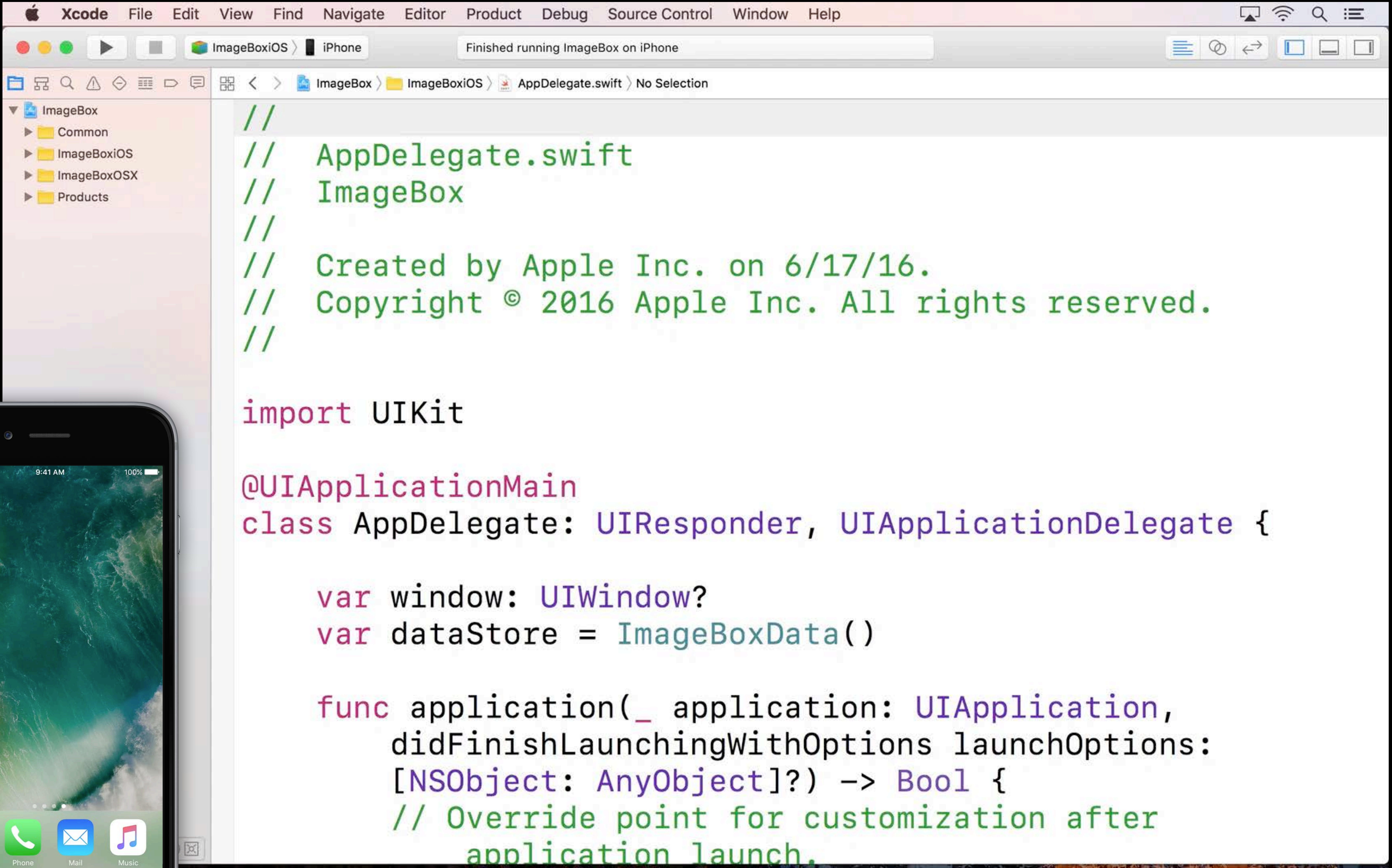
```swift
//
//  AppDelegate.swift
//  ImageBox
//
//  Created by Apple Inc. on 6/17/16.
//  Copyright © 2016 Apple Inc. All rights reserved.
//

import UIKit

@UIApplicationMain
class AppDelegate: UIResponder, UIApplicationDelegate {

    var window: UIWindow?
    var dataStore = ImageBoxData()

    func application(_ application: UIApplication,
        didFinishLaunchingWithOptions launchOptions:
        [NSObject: AnyObject]?) -> Bool {
        // Override point for customization after
            application launch.
```



```
//
//  AppDelegate.swift
//  ImageBox
//
//  Created by Apple Inc. on 6/17/16.
//  Copyright © 2016 Apple Inc. All rights reserved.
//

import UIKit

@UIApplicationMain
class AppDelegate: UIResponder, UIApplicationDelegate {

    var window: UIWindow?
    var dataStore = ImageBoxData()

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        didFinishLaunchingWithOptions launchOptions:
        [NSObject: AnyObject]?) -> Bool {
        // Override point for customization after
            application launch.
```
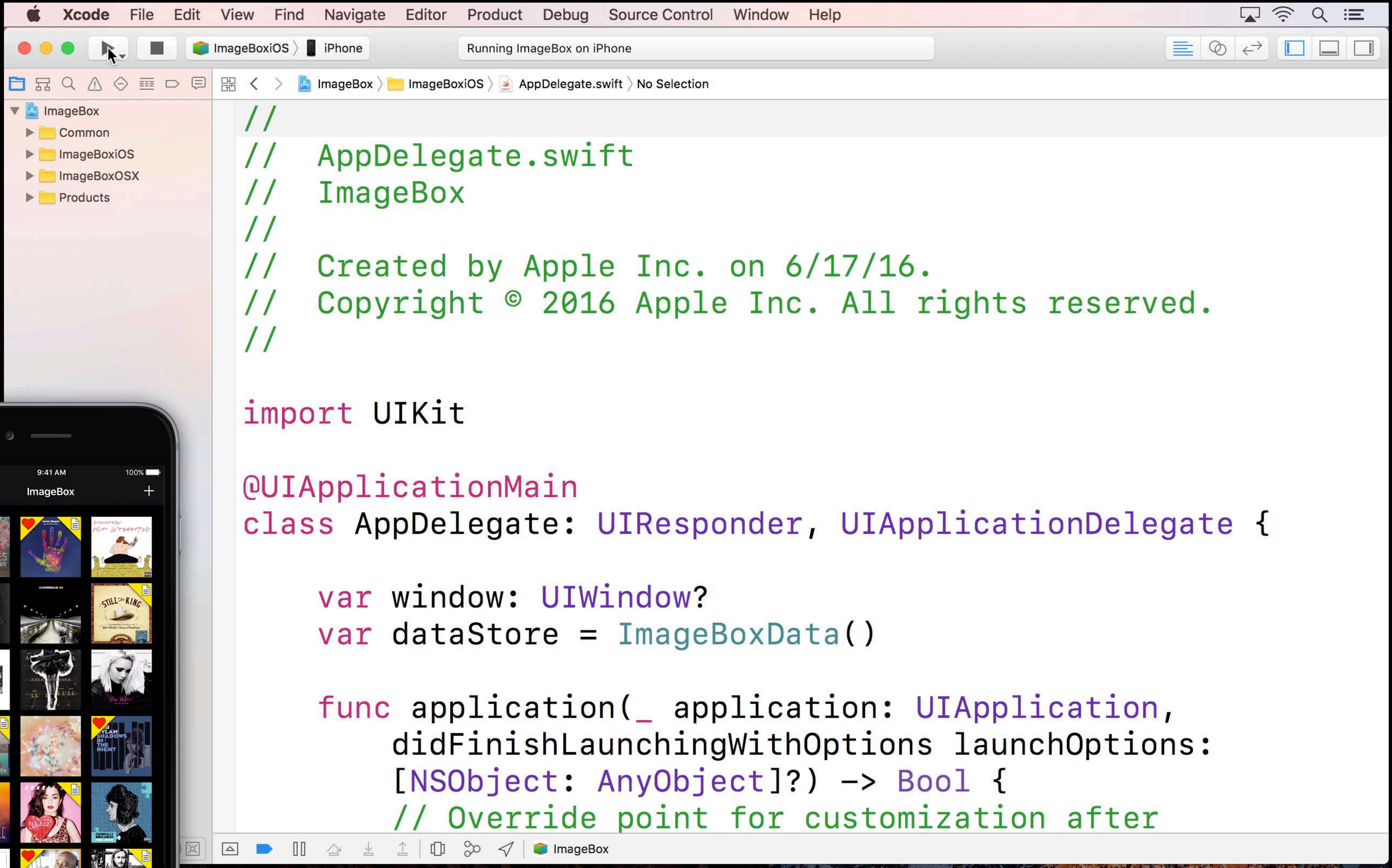
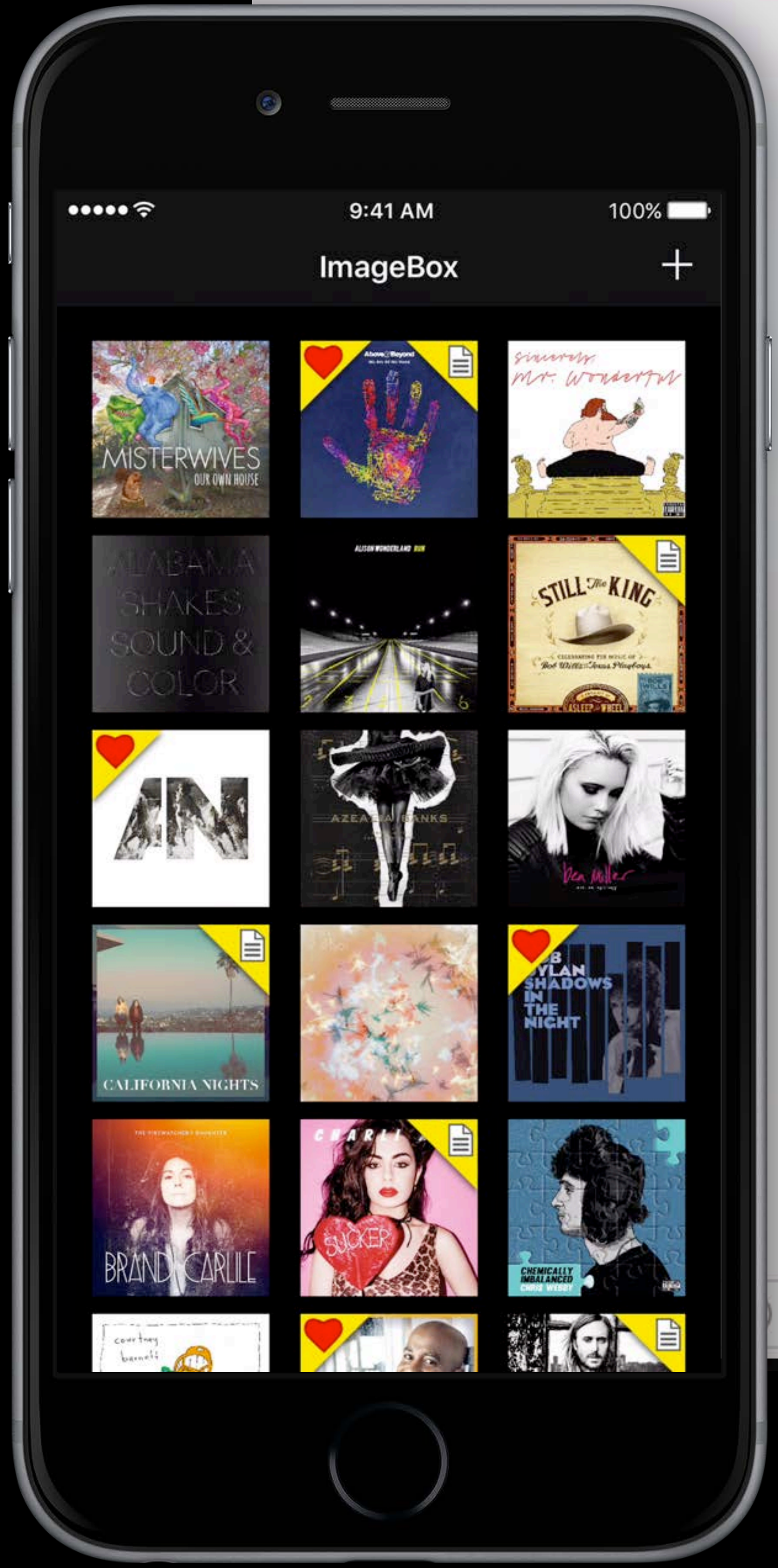
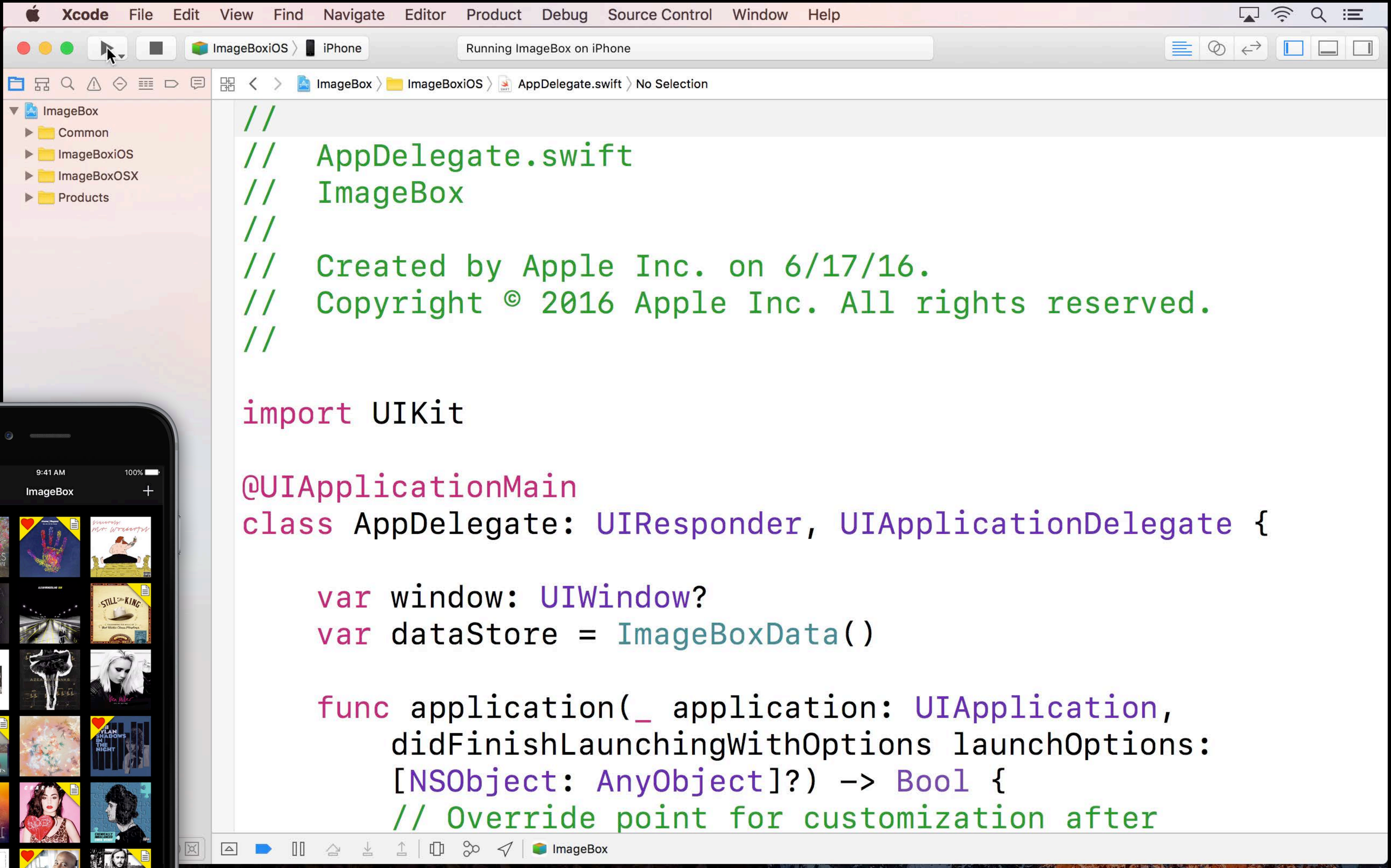
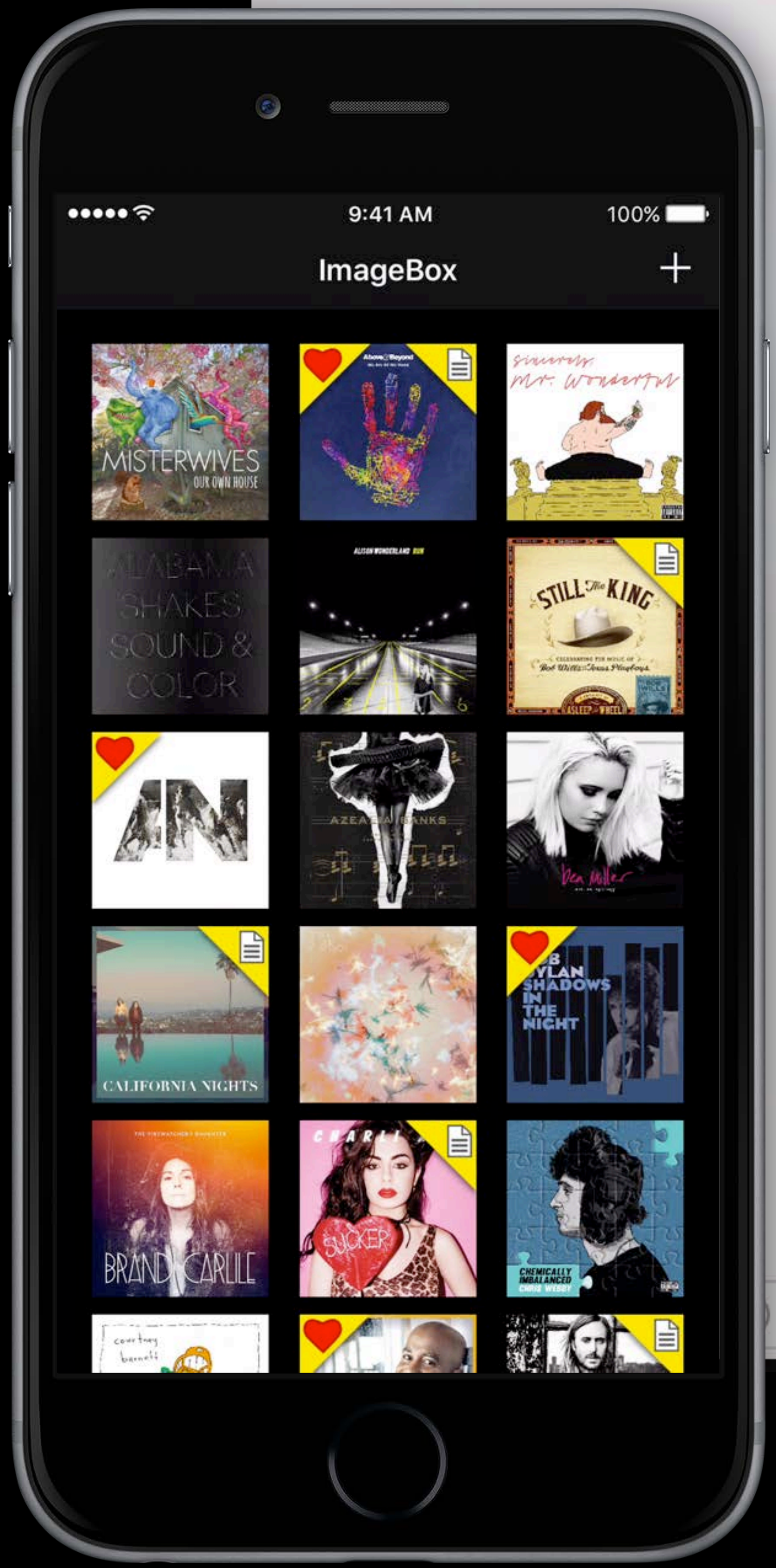


Xcode File Edit View Find Navigate Editor Product Debug Source Control Window Help
ImageBoxiOS 〉 iPhone
Running ImageBox on iPhone
ImageBox 〉 ImageBoxiOS 〉 AppDelegate.swift 〉 No Selection
ImageBox
Common
ImageBoxiOS
ImageBoxOSX
Products
ImageBox

```swift
//
//  AppDelegate.swift
//  ImageBox
//
//  Created by Apple Inc. on 6/17/16.
//  Copyright © 2016 Apple Inc. All rights reserved.
//

import UIKit

@UIApplicationMain
class AppDelegate: UIResponder, UIApplicationDelegate {

    var window: UIWindow?
    var dataStore = ImageBoxData()

    func application(_ application: UIApplication,
        didFinishLaunchingWithOptions launchOptions:
        [NSObject: AnyObject]?) -> Bool {
        // Override point for customization after
```





```
//
//  AppDelegate.swift
//  ImageBox
//
//  Created by Apple Inc. on 6/17/16.
//  Copyright © 2016 Apple Inc. All rights reserved.
//

import UIKit

@UIApplicationMain
class AppDelegate: UIResponder, UIApplicationDelegate {

    var window: UIWindow?
    var dataStore = ImageBoxData()

    func application(_ application: UIApplication,
        didFinishLaunchingWithOptions launchOptions:
        [NSObject: AnyObject]?) -> Bool {
        // Override point for customization after
```



Use the Right Thread

Play by the Rules

Main thread

Play by the Rules

Main thread

Primary uses

- User input ✓
- User interface

Play by the Rules

Main thread

Primary uses ✓

- User input
- User interface

Not intended for ✗

- Long running tasks
- I/O

A Day at the Beach

Symptoms of a busy main thread

A Day at the Beach

Symptoms of a busy main thread

A Day at the Beach

Symptoms of a busy main thread

Spins

A Day at the Beach

Symptoms of a busy main thread

Spins

Unresponsive UI

A Day at the Beach

Symptoms of a busy main thread

Spins

Unresponsive UI

Animation stutters

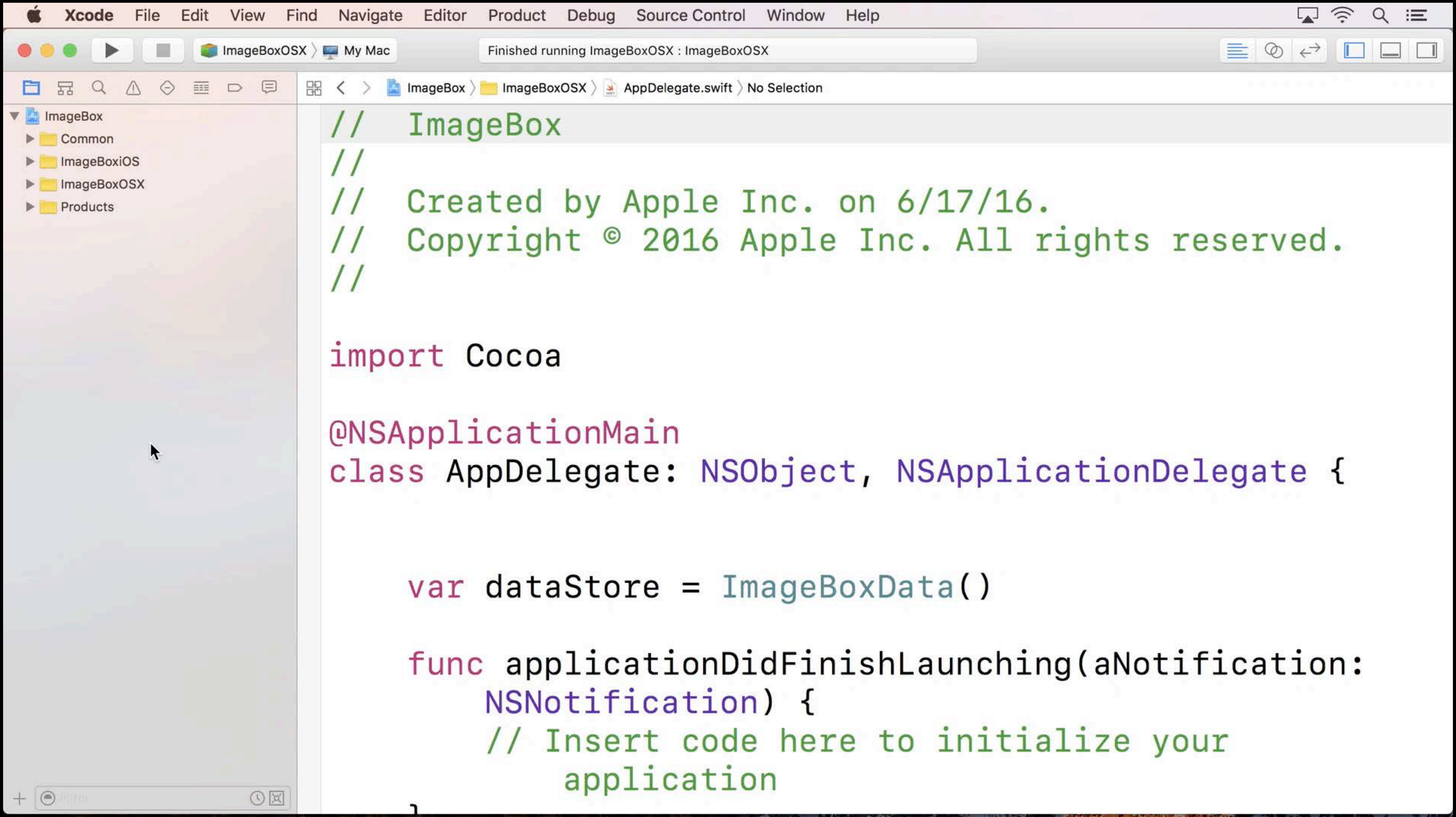
A Day at the Beach

Symptoms of a busy main thread

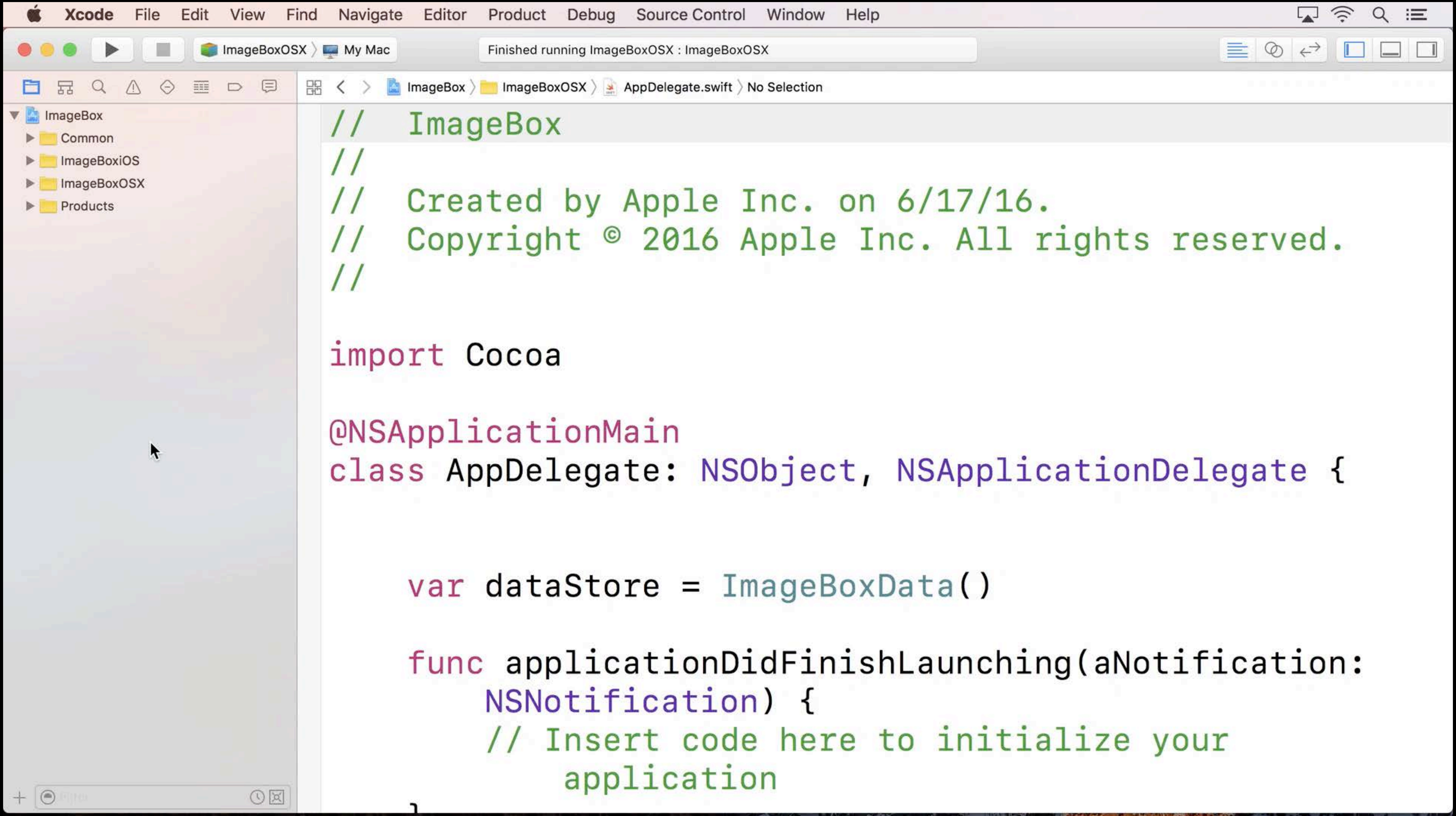
Spins

Unresponsive UI

Animation stutters


Xcode File Edit View Find Navigate Editor Product Debug Source Control Window Help
ImageBoxOSX 〉 My Mac
Finished running ImageBoxOSX : ImageBoxOSX
ImageBox 〉 ImageBoxOSX 〉 AppDelegate.swift 〉 No Selection
ImageBox
Common
ImageBoxiOS
ImageBoxOSX
Products

```
//  ImageBox
//
//  Created by Apple Inc. on 6/17/16.
//  Copyright © 2016 Apple Inc. All rights reserved.
//

import Cocoa

@NSApplicationMain
class AppDelegate: NSObject, NSApplicationDelegate {


    var dataStore = ImageBoxData()

    func applicationDidFinishLaunching(aNotification:
        NSNotification) {
        // Insert code here to initialize your
            application
```



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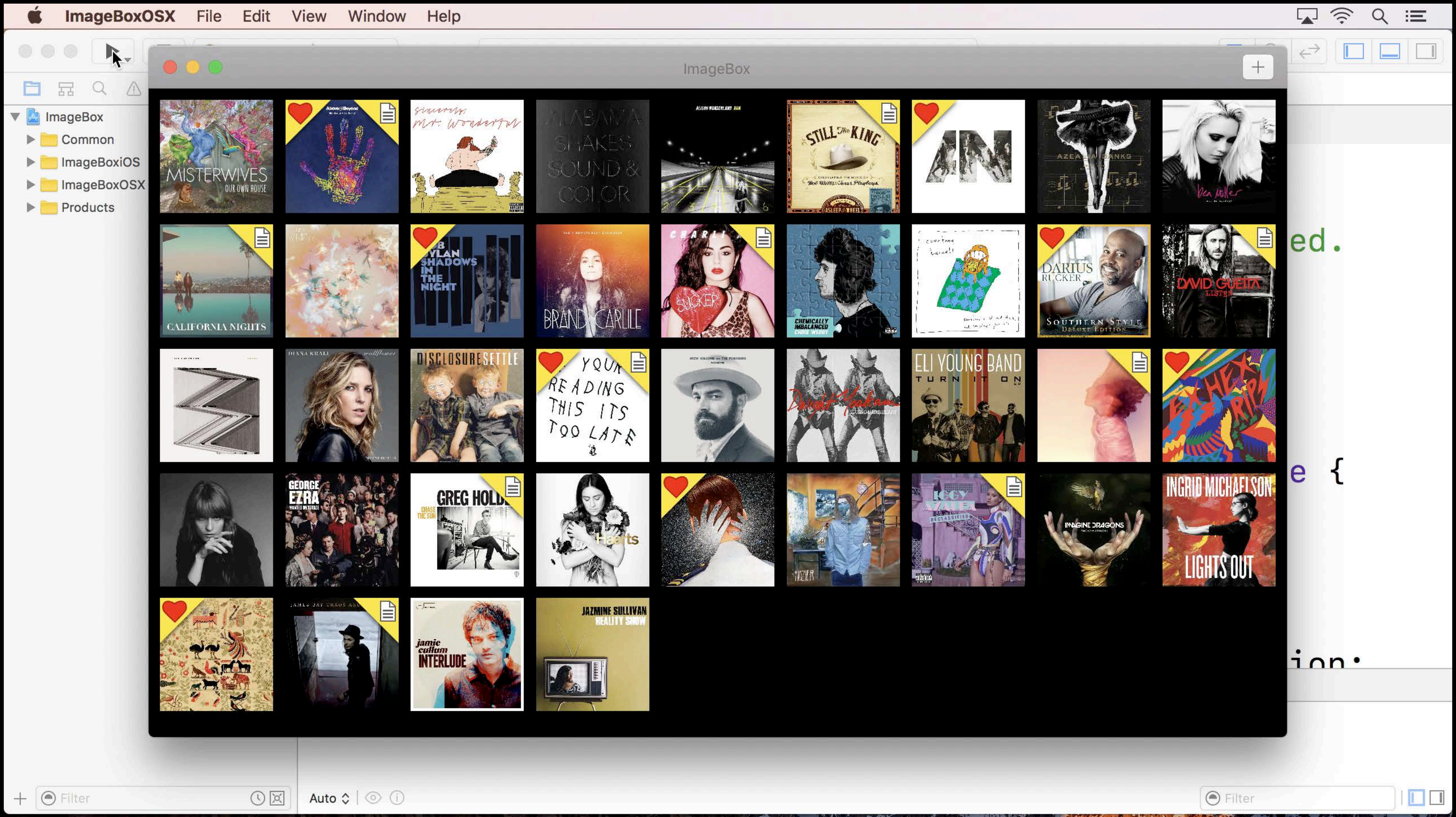
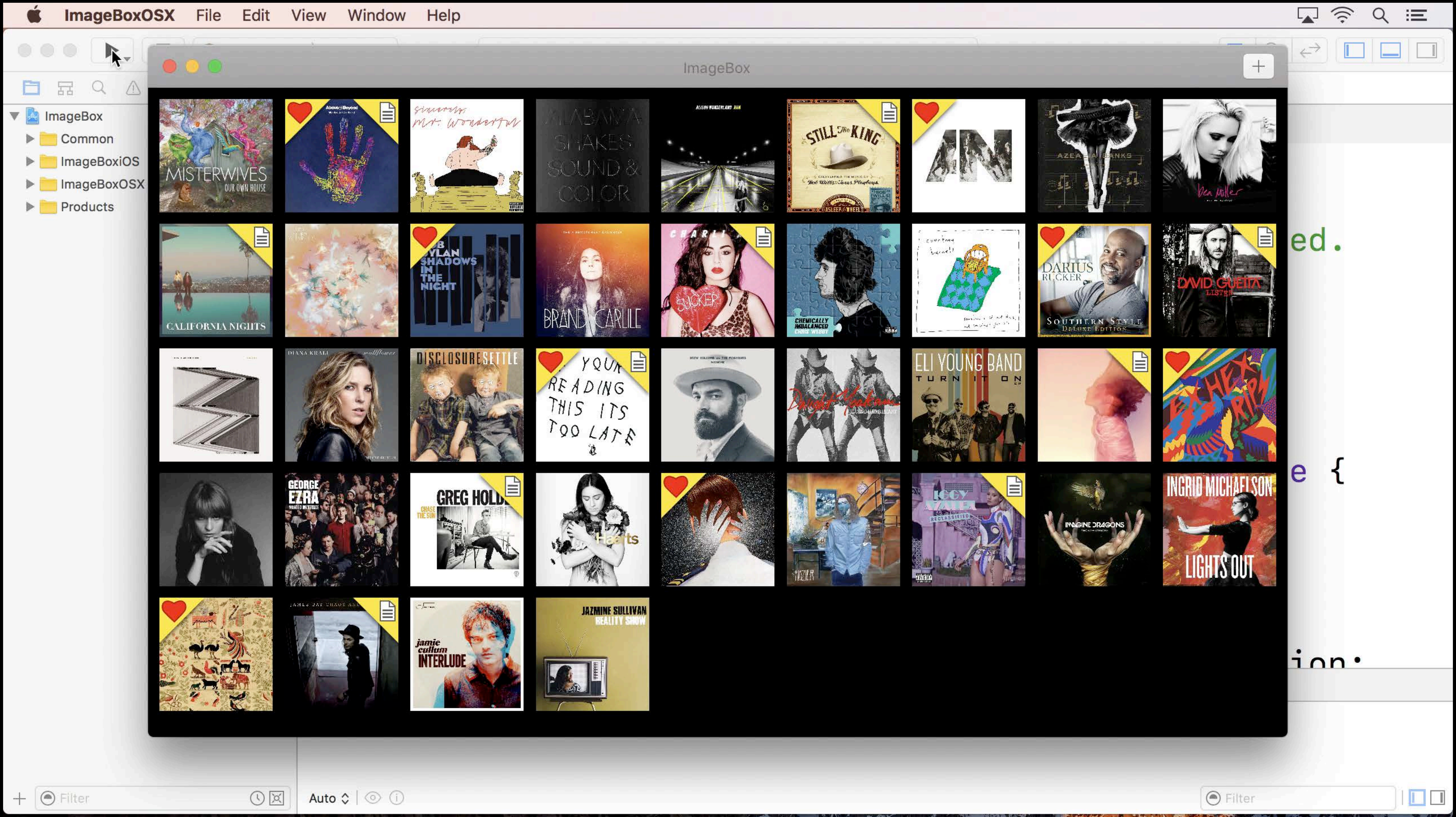

ImageBoxOSX
File
Edit
View
Window
Help
ImageBox
ImageBox
Common
ImageBoxiOS
ImageBoxOSX
Products
Filter
Auto
Filter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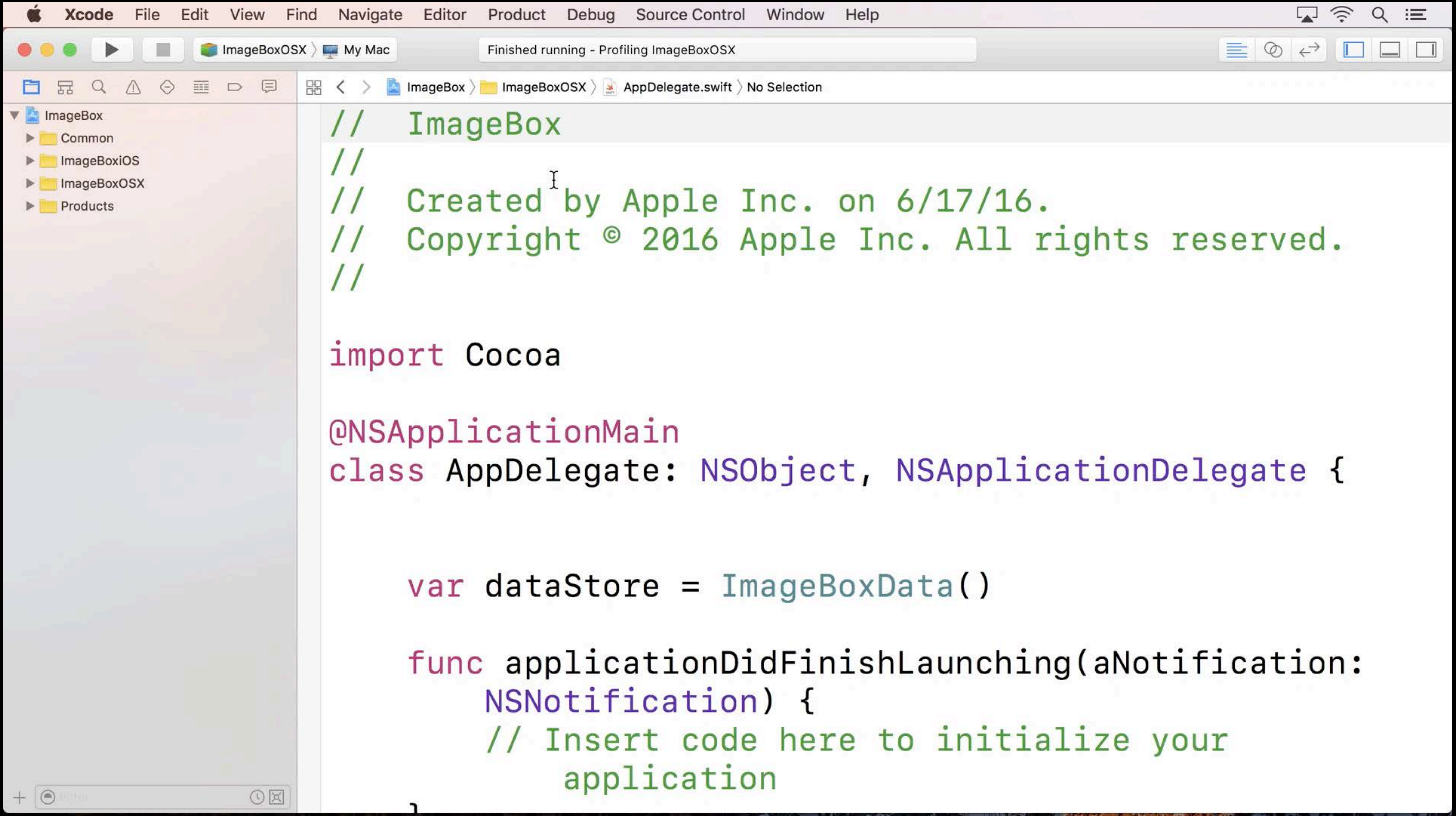

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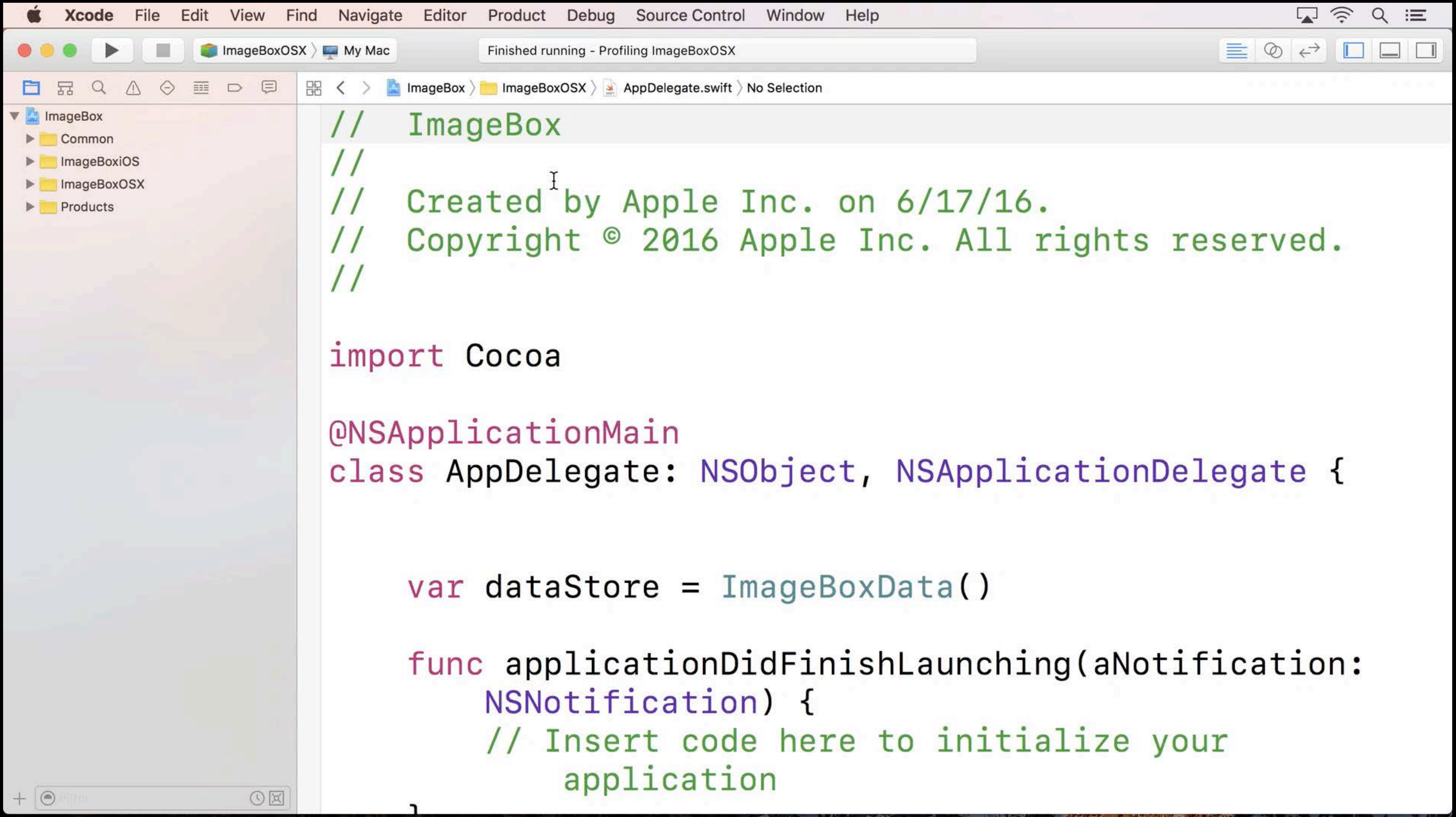

```swift
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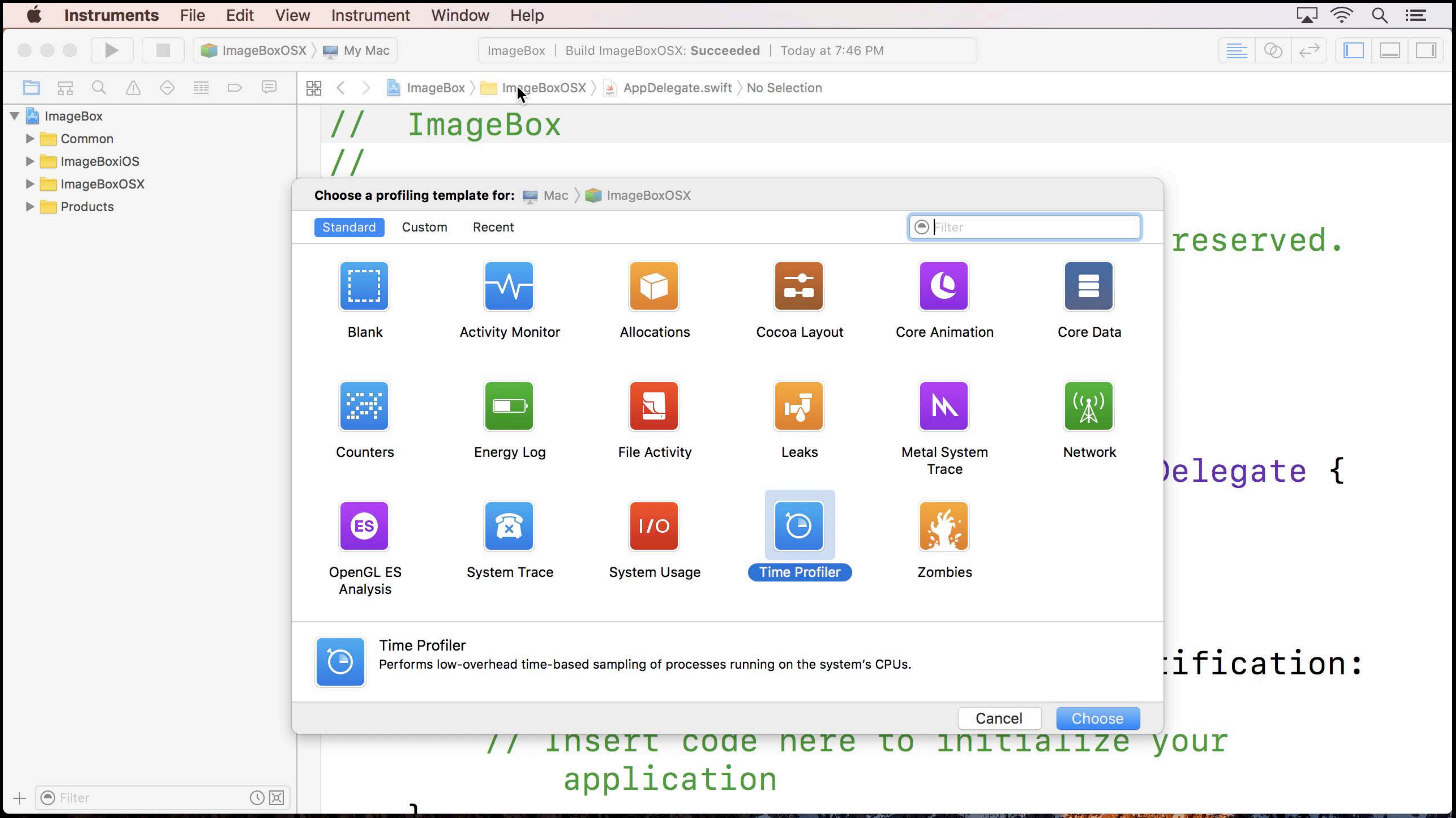

```
//  ImageBox
//
...reserved.
...Delegate {
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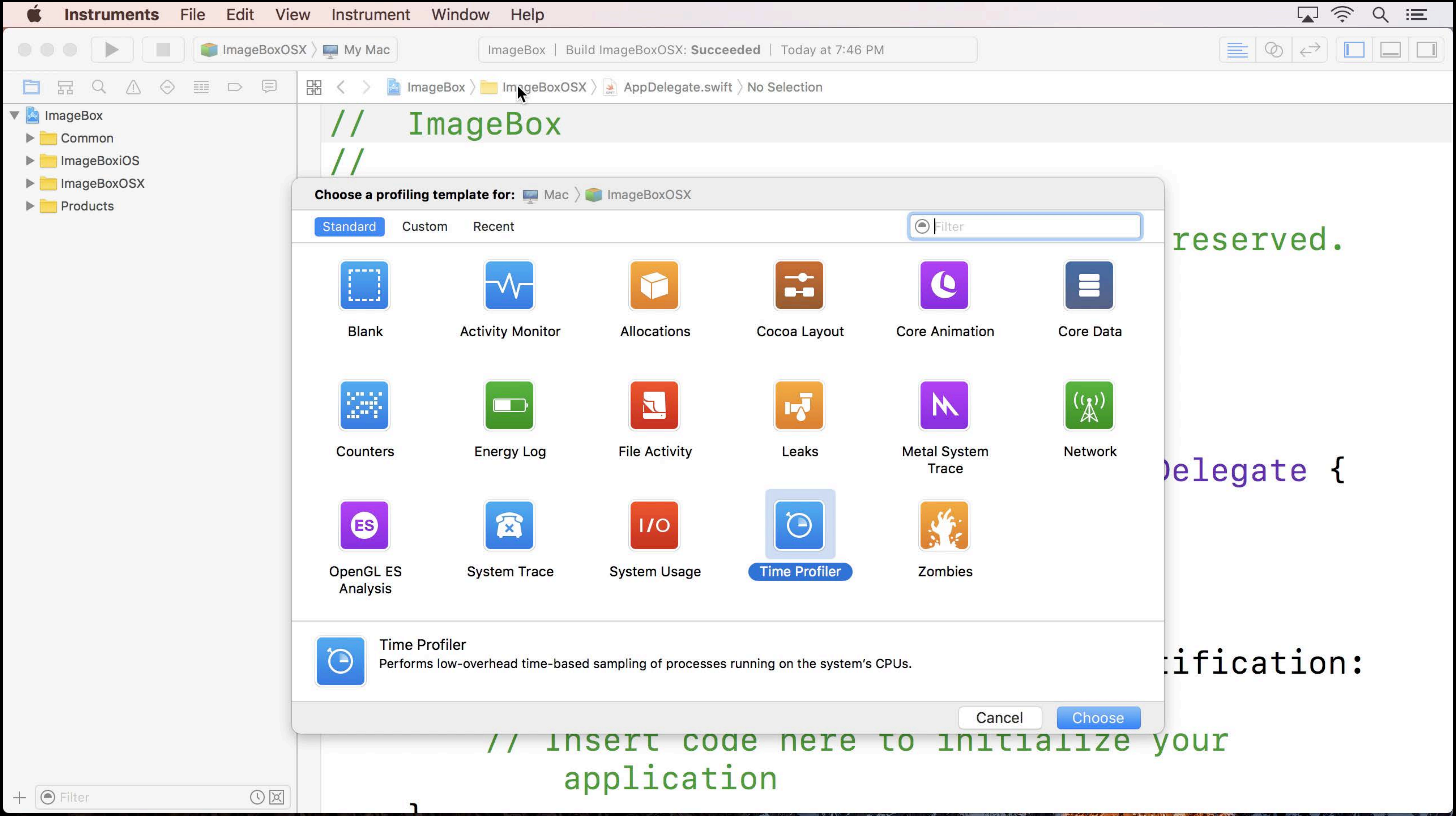
```

Time Profiler
Performs low-overhead time-based sampling of processes running on the system's CPUs.



Choose a profiling template for: Mac 〉 ImageBoxOSX

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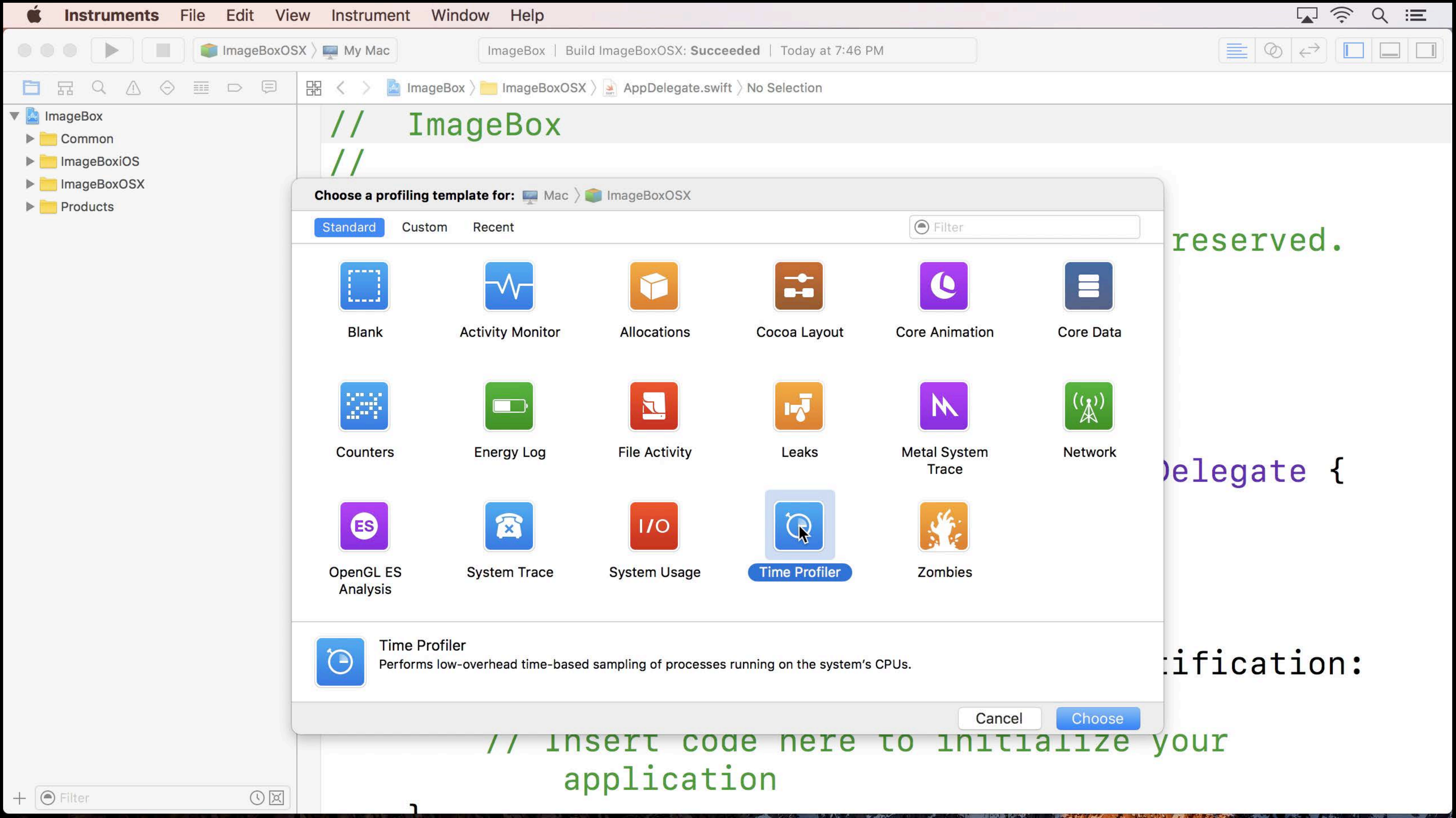

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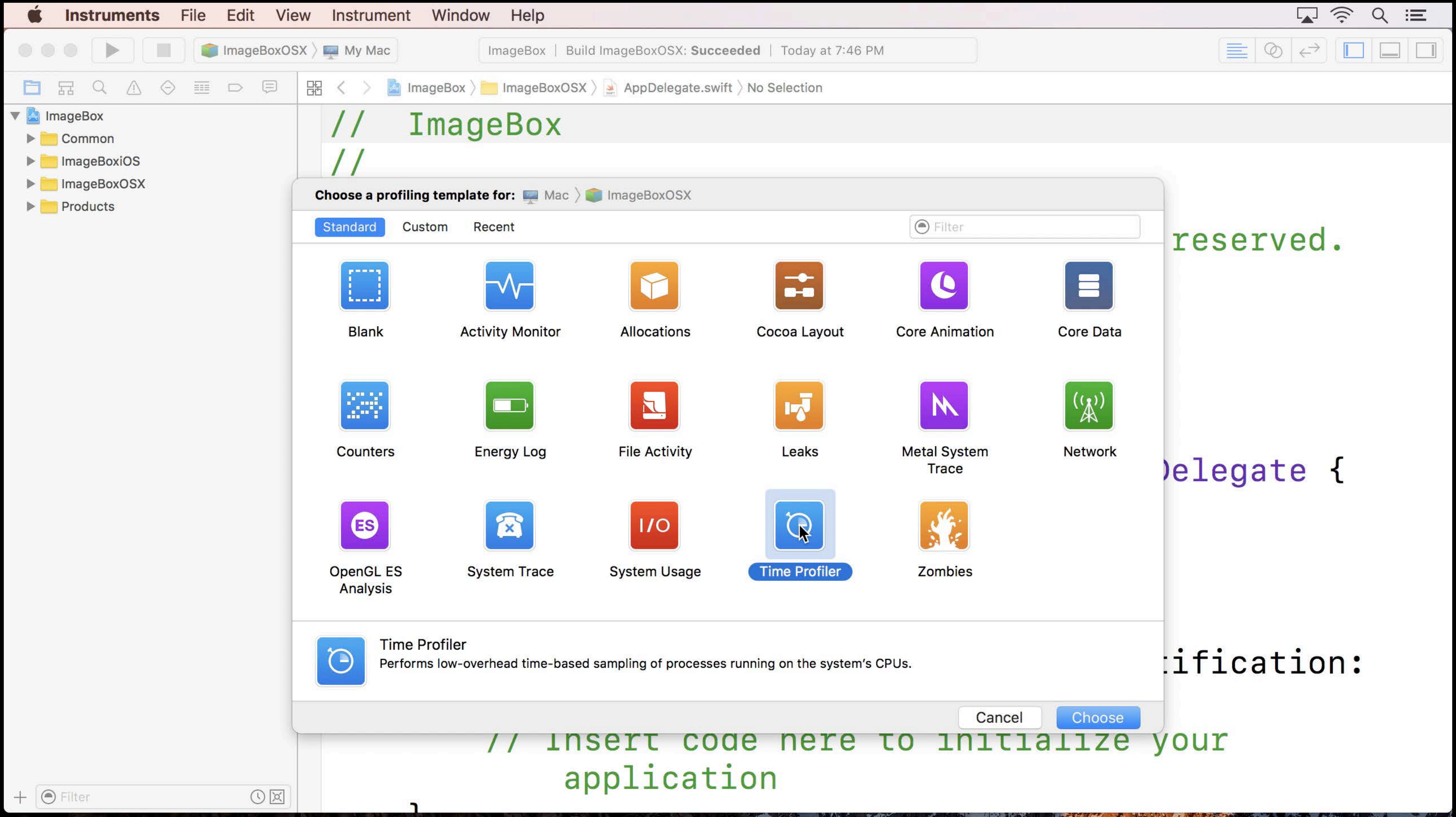

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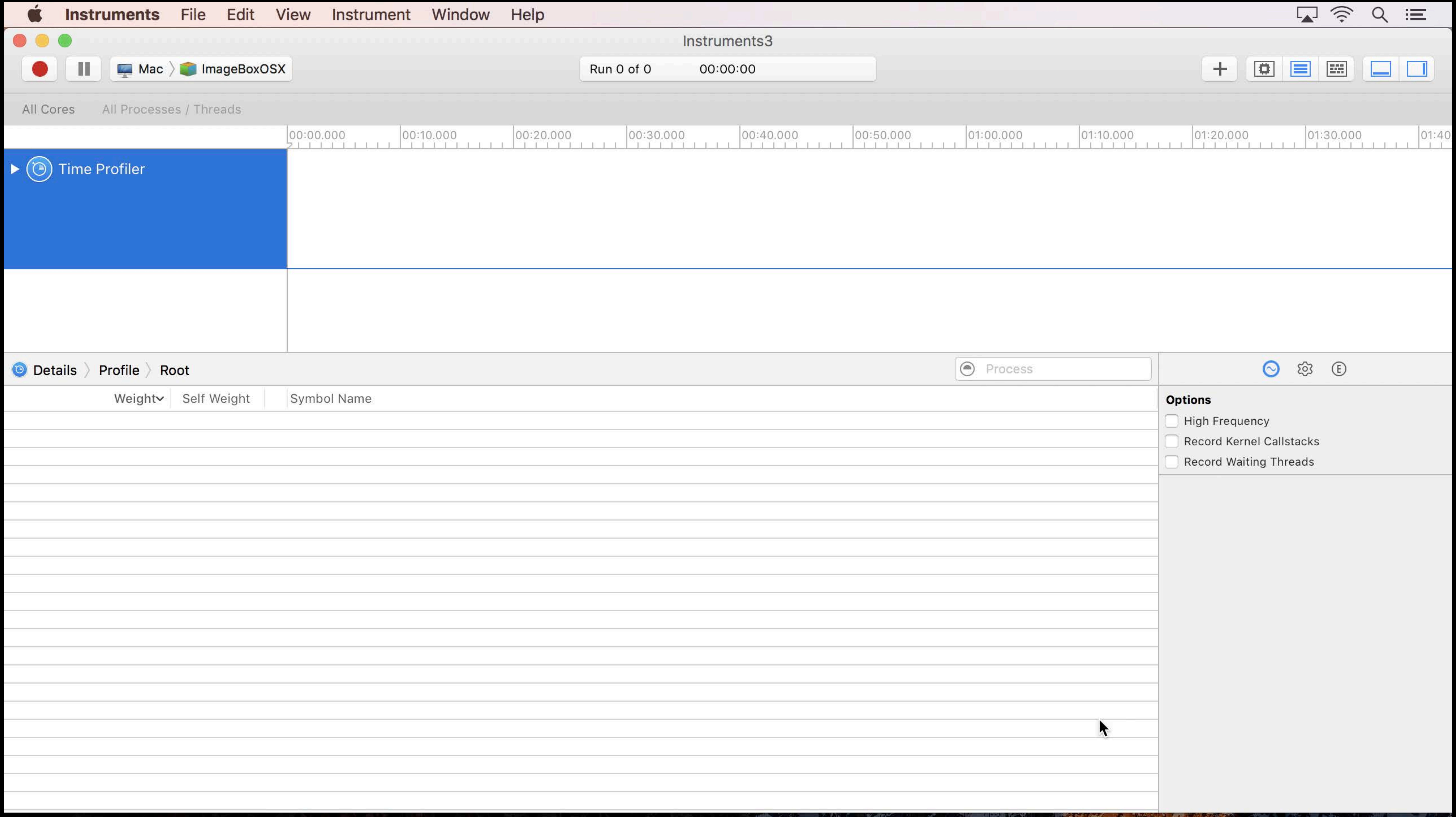
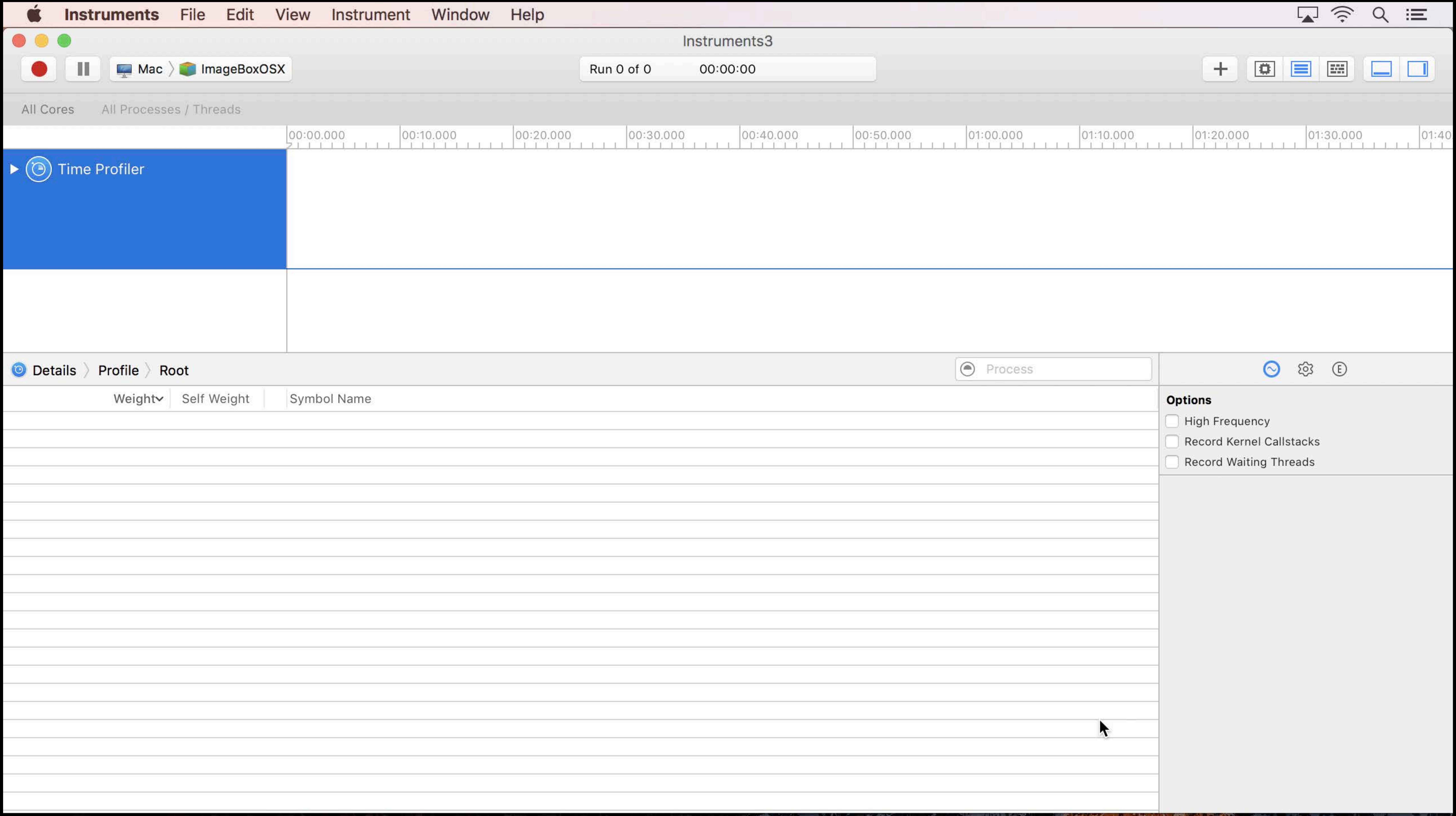


Options

- [ ] High Frequency
- [ ] Record Kernel Callstacks
- [ ] Record Waiting Threads

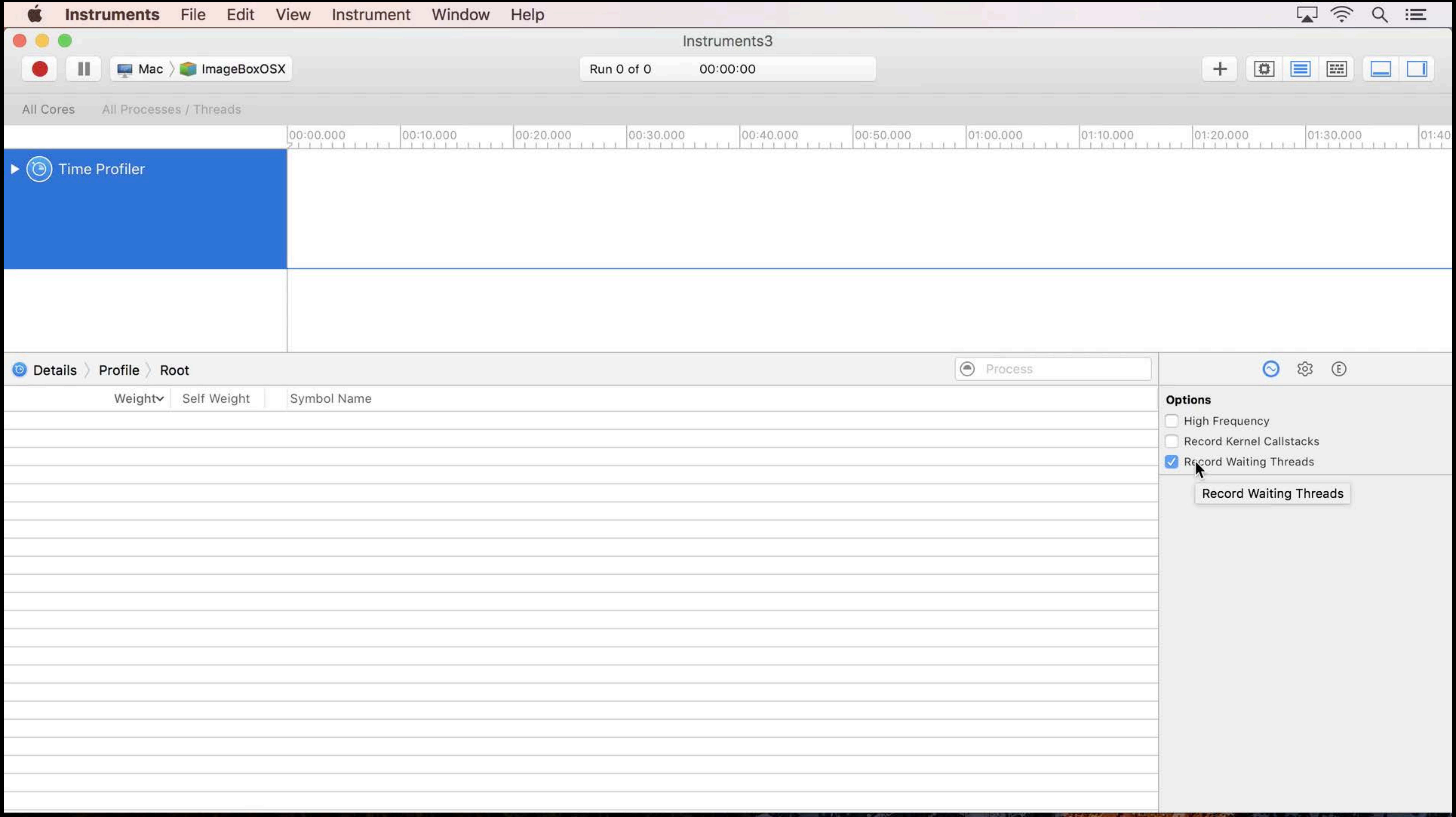


Options

High Frequency

Record Kernel Callstacks

Record Waiting Threads



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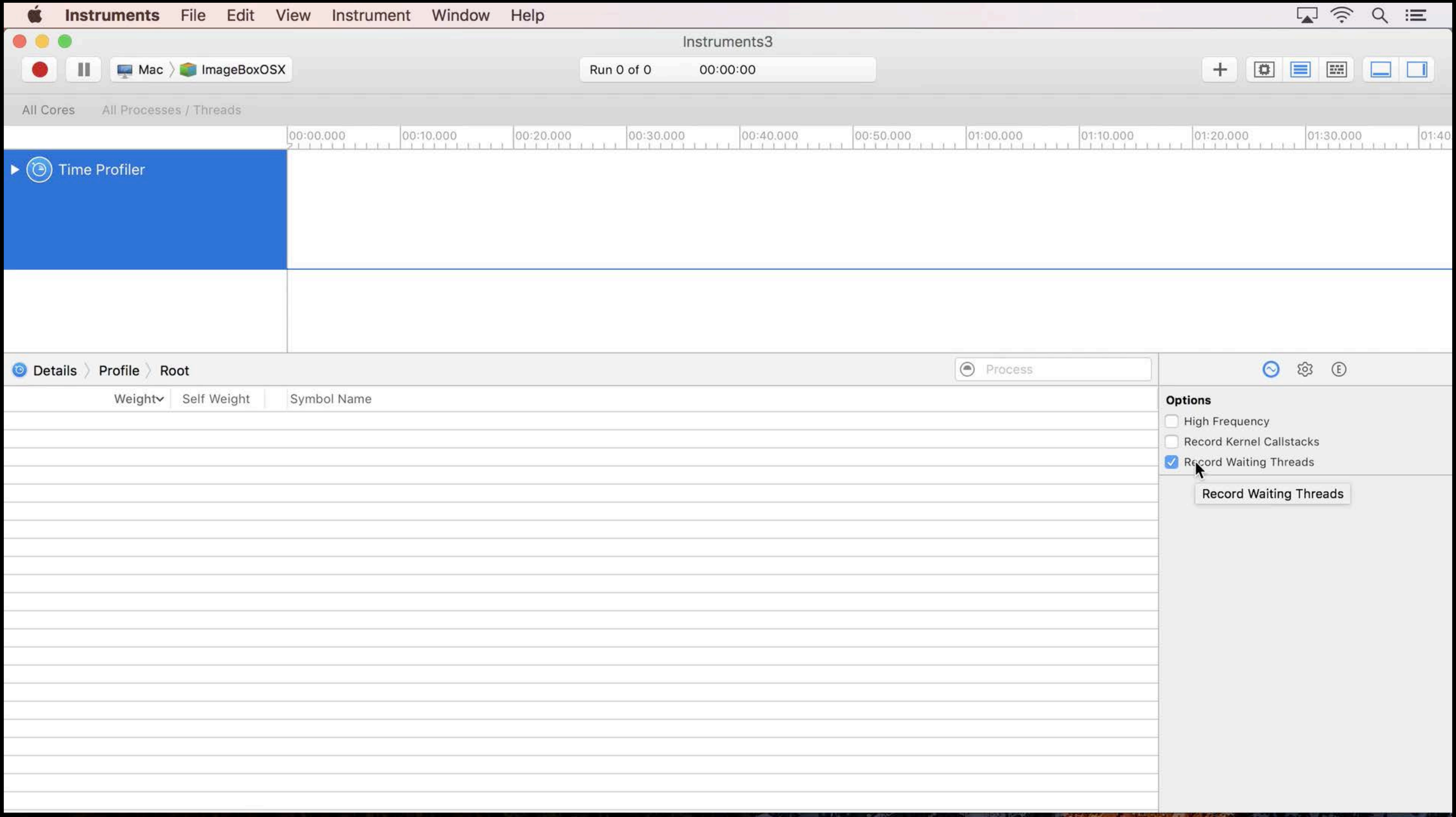

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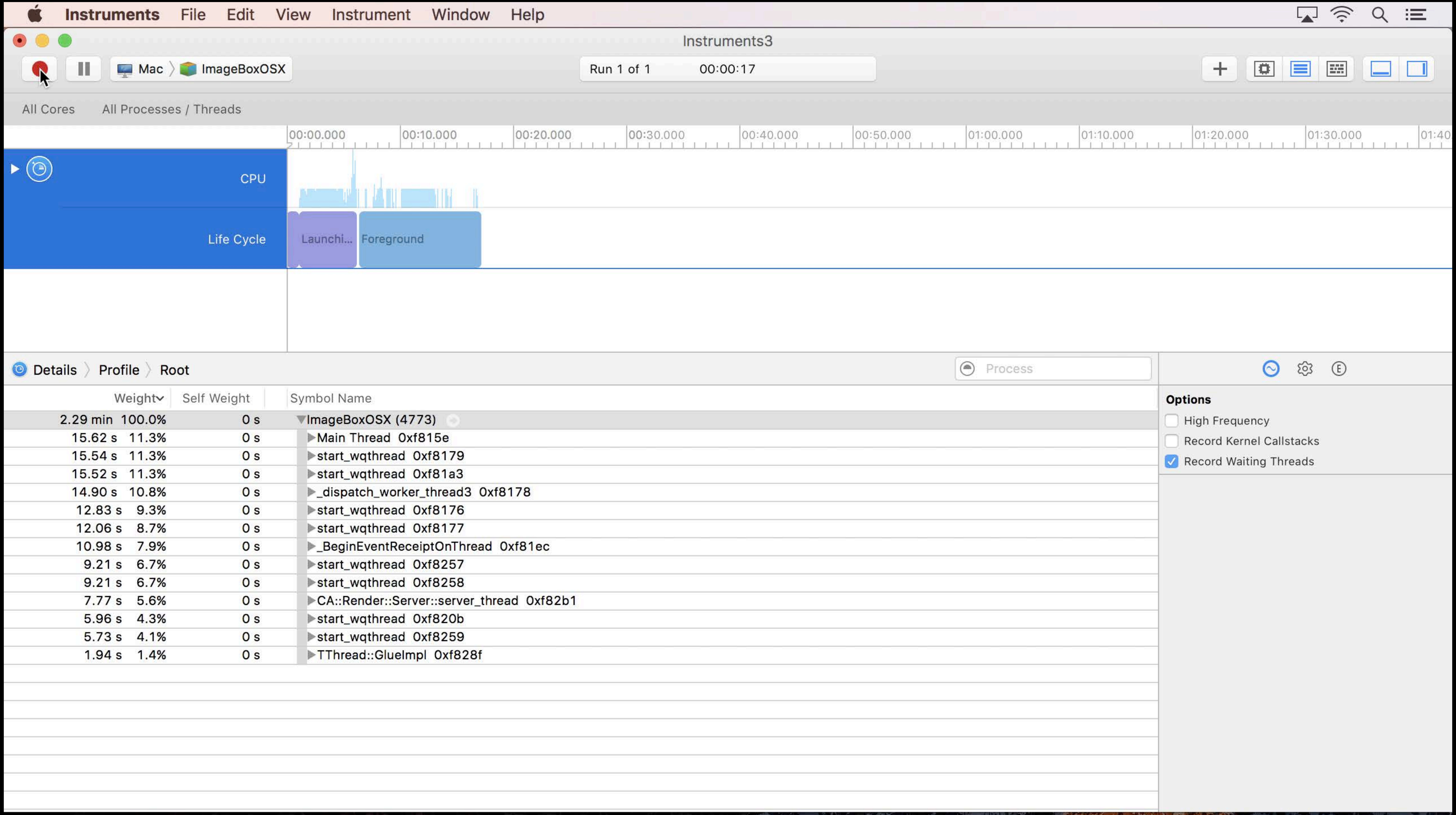
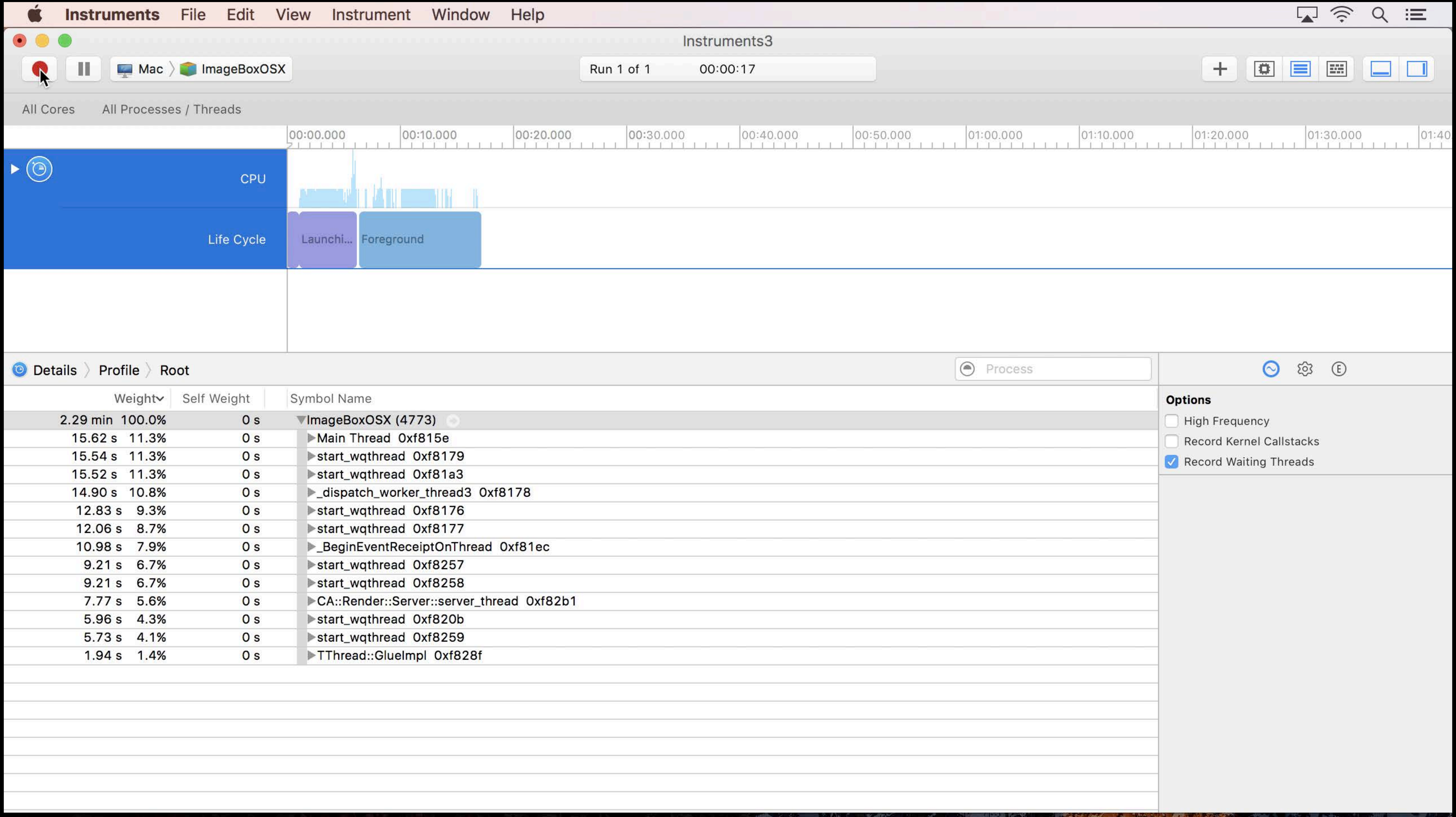


Weight		Self Weight	Symbol Name
2.29 min	100.0%	0 s	ImageBoxOSX (4773)
15.62 s	11.3%	0 s	Main Thread 0xf815e
15.54 s	11.3%	0 s	start_wqthread 0xf8179
15.52 s	11.3%	0 s	start_wqthread 0xf81a3
14.90 s	10.8%	0 s	_dispatch_worker_thread3 0xf8178
12.83 s	9.3%	0 s	start_wqthread 0xf8176
12.06 s	8.7%	0 s	start_wqthread 0xf8177
10.98 s	7.9%	0 s	_BeginEventReceiptOnThread 0xf81ec
9.21 s	6.7%	0 s	start_wqthread 0xf8257
9.21 s	6.7%	0 s	start_wqthread 0xf8258
7.77 s	5.6%	0 s	CA::Render::Server::server_thread 0xf82b1
5.96 s	4.3%	0 s	start_wqthread 0xf820b
5.73 s	4.1%	0 s	start_wqthread 0xf8259
1.94 s	1.4%	0 s	TThread::GlueImpl 0xf828f

Options

- ☐ High Frequency
- ☐ Record Kernel Callstacks
- ☑ Record Waiting Threads



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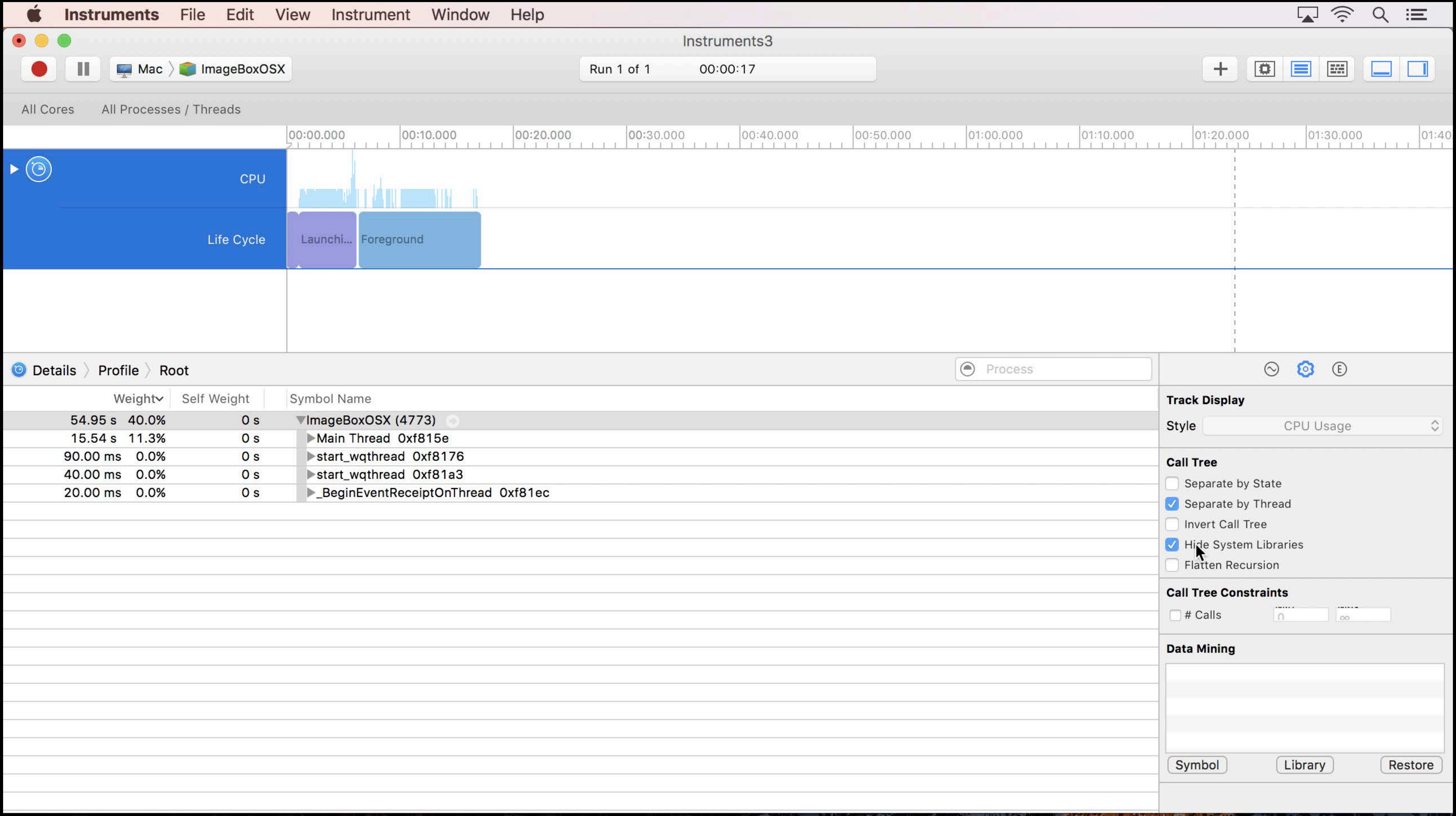


Weight		Self Weight	Symbol Name
54.95 s	40.0%	0 s	▼ImageBoxOSX (4773)
15.54 s	11.3%	0 s	▶Main Thread 0xf815e
90.00 ms	0.0%	0 s	▶start_wqthread 0xf8176
40.00 ms	0.0%	0 s	▶start_wqthread 0xf81a3
20.00 ms	0.0%	0 s	▶_BeginEventReceiptOnThread 0xf81ec

Track Display

Style: CPU Usage

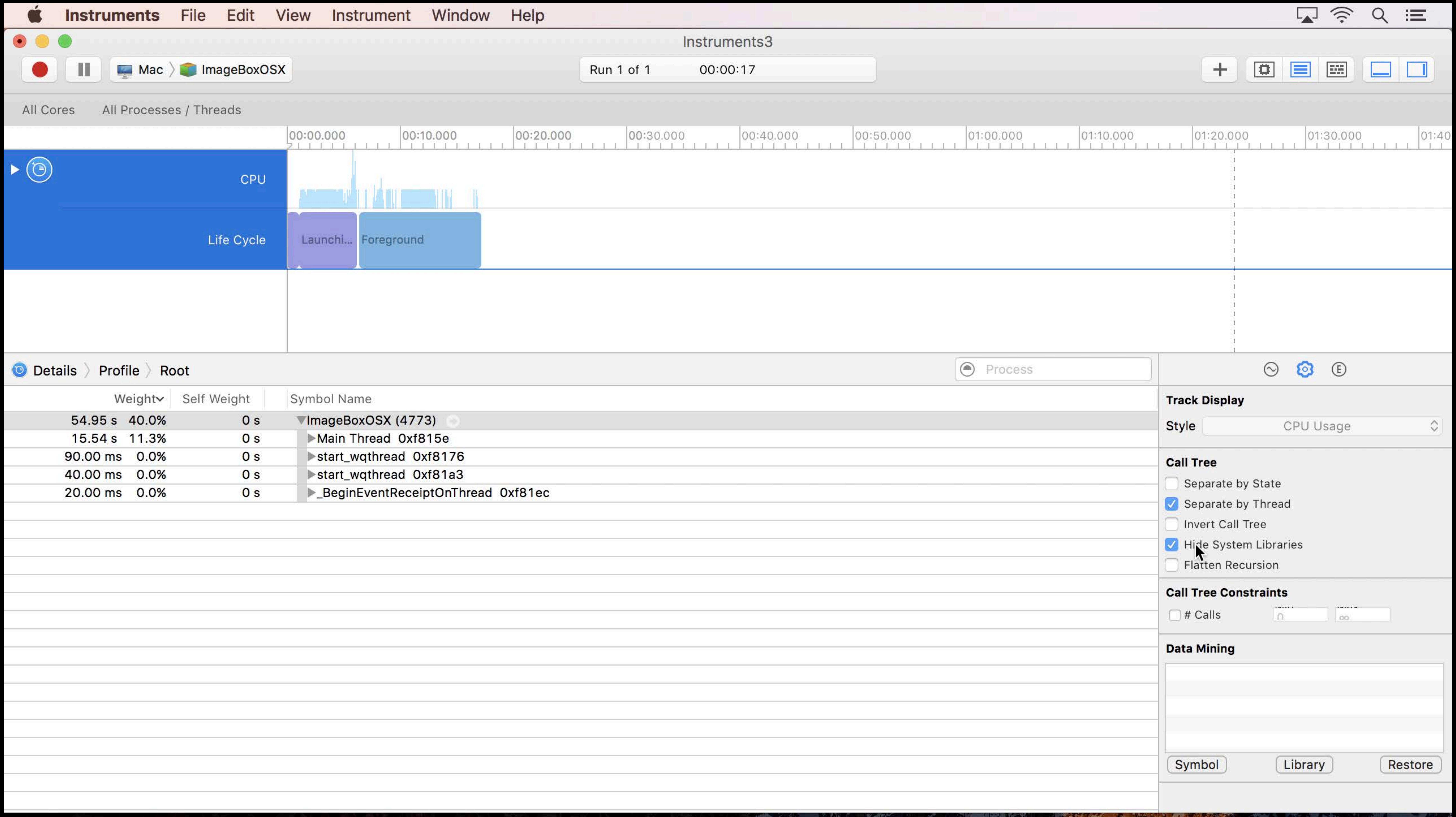
Call Tree

- [ ] Separate by State
- [x] Separate by Thread
- [ ] Invert Call Tree
- [x] Hide System Libraries
- [ ] Flatten Recursion

Call Tree Constraints

- [ ] # Calls

Data Mining



Run 1 of 1 00:00:17

00:00.000 00:10.000 00:20.000 00:30.000 00:40.000 00:50.000 01:00.000 01:10.000 01:20.000 01:30.000 01:40

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Call Tree Constraints

- [ ] # Calls 0 ∞

Data Mining

Main Thread

Improper use

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NSOpenPanel().begin { (response) in
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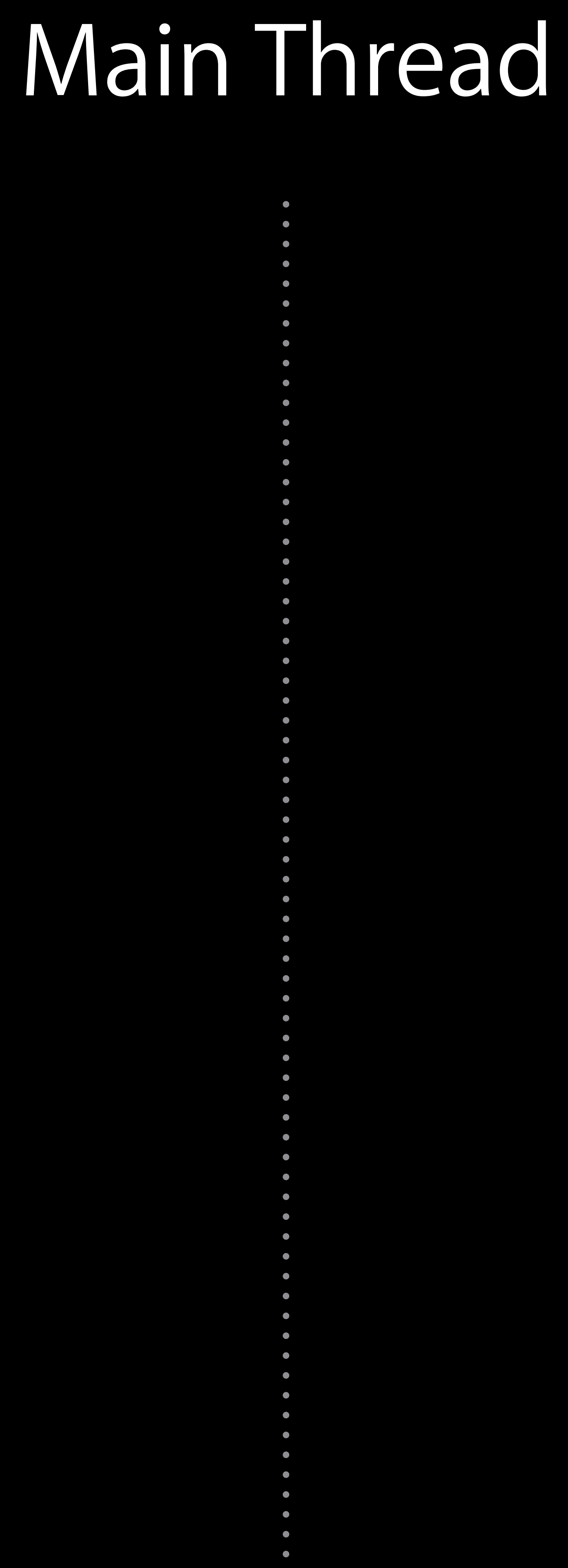
Main Thread

Responsive UI

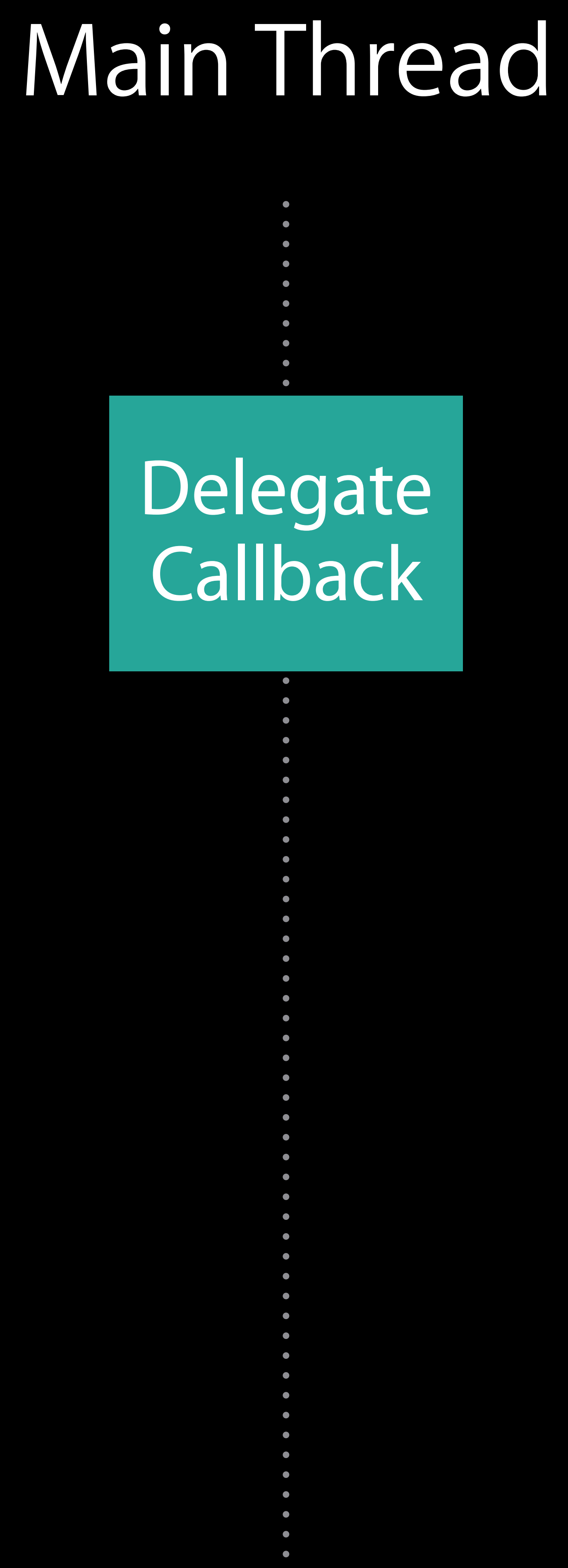
Main Thread

Responsive UI



Main Thread

Responsive UI



Main Thread

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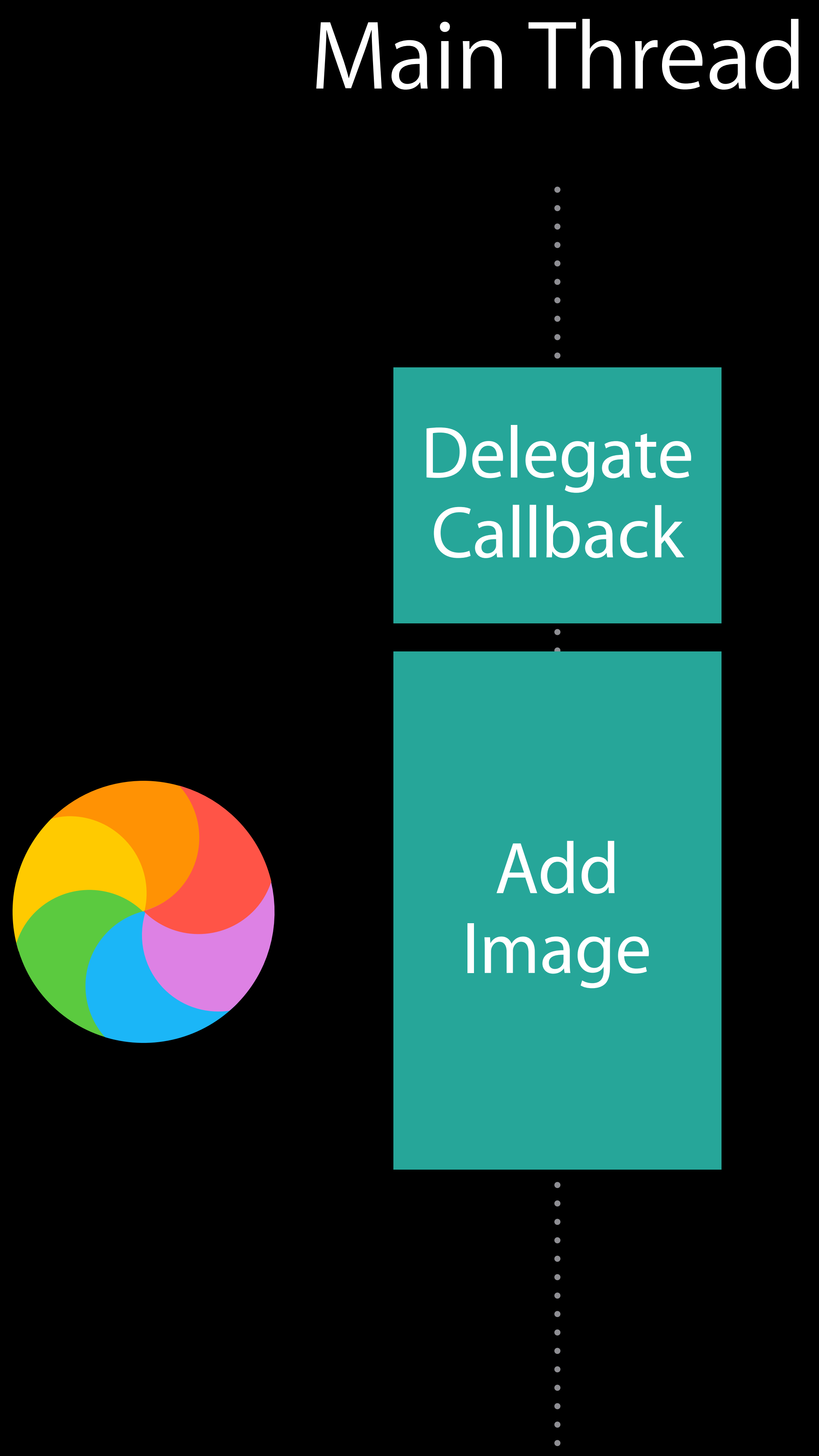

Main Thread

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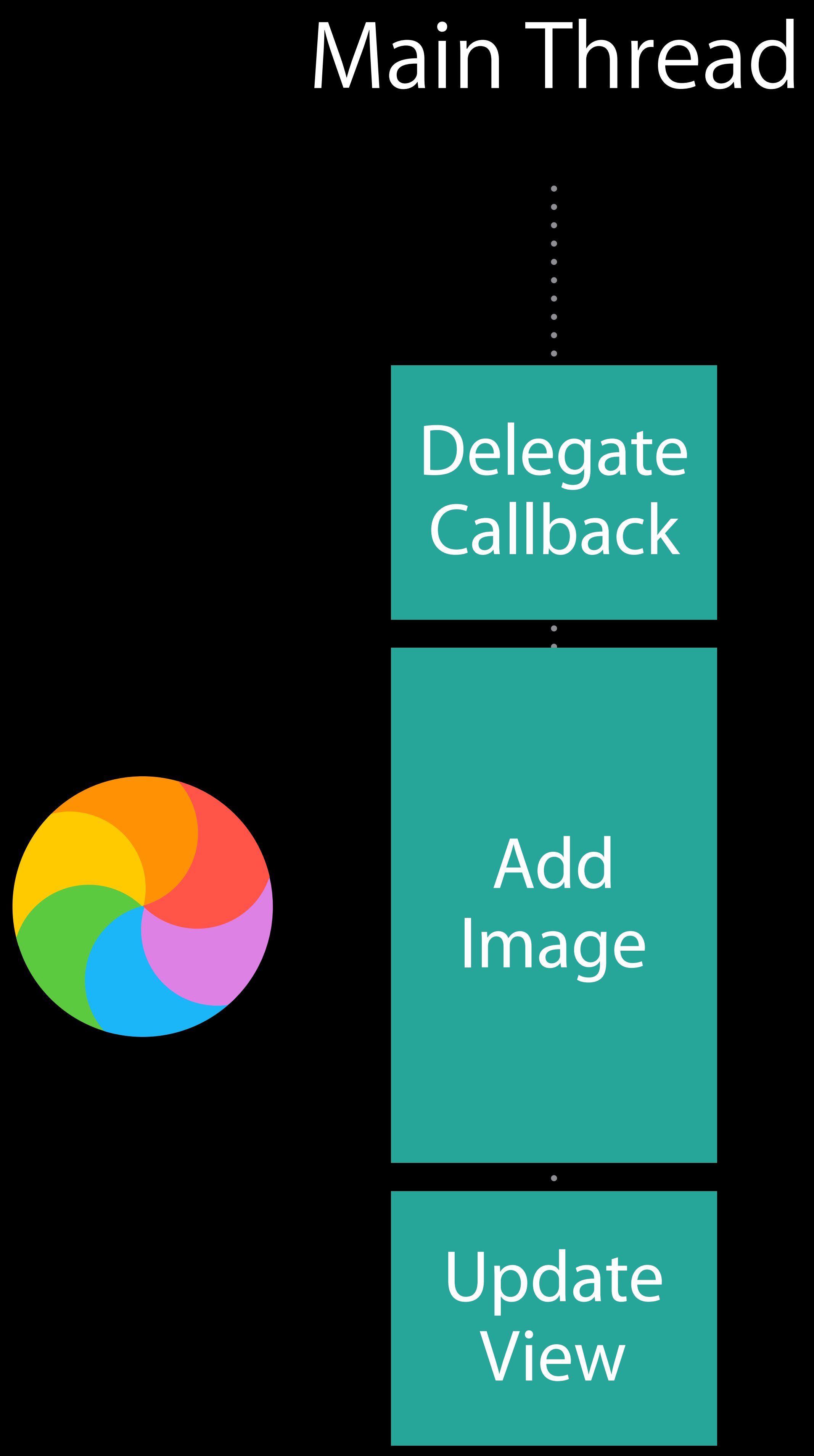

Main Thread

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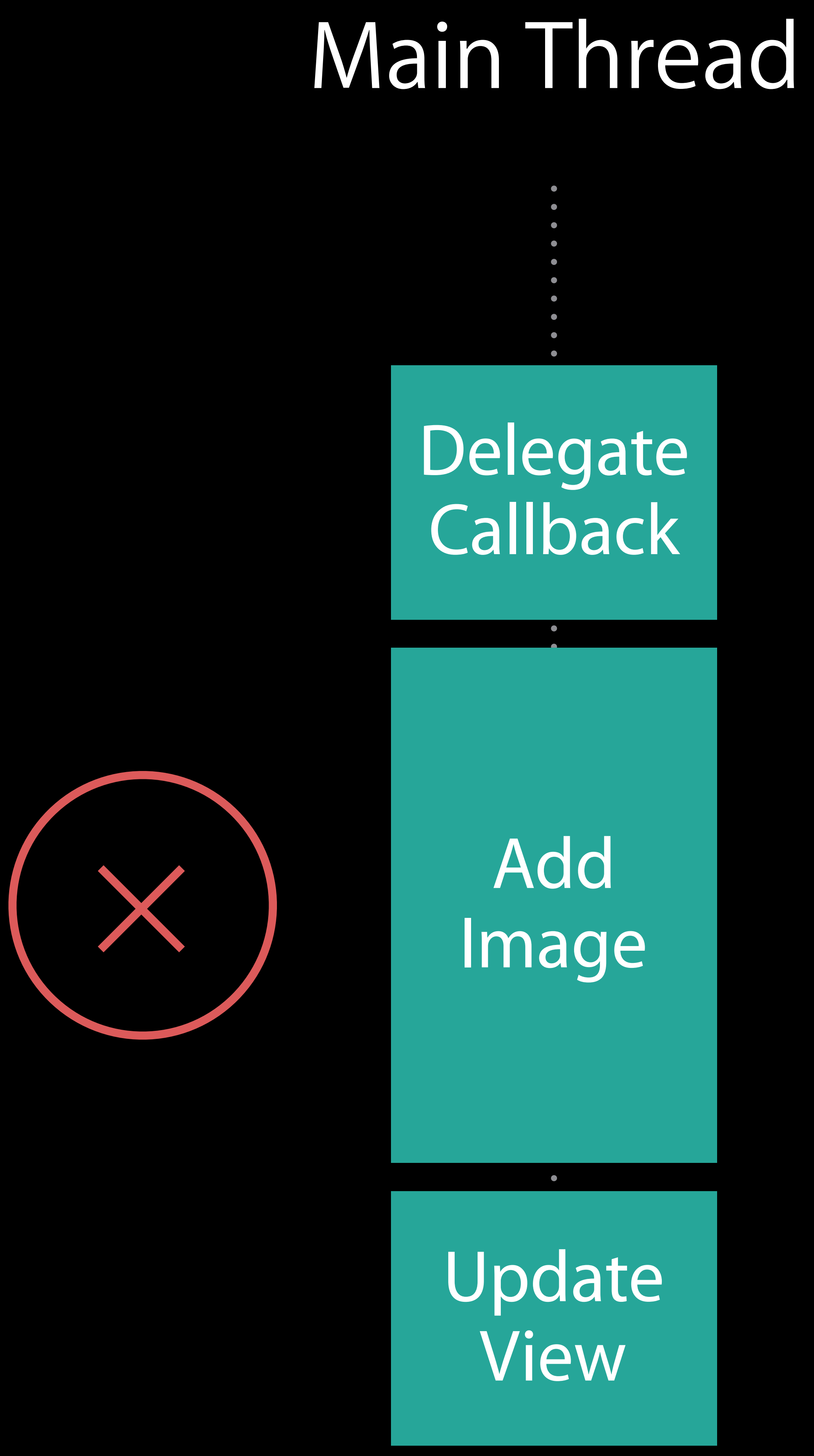

Main Thread

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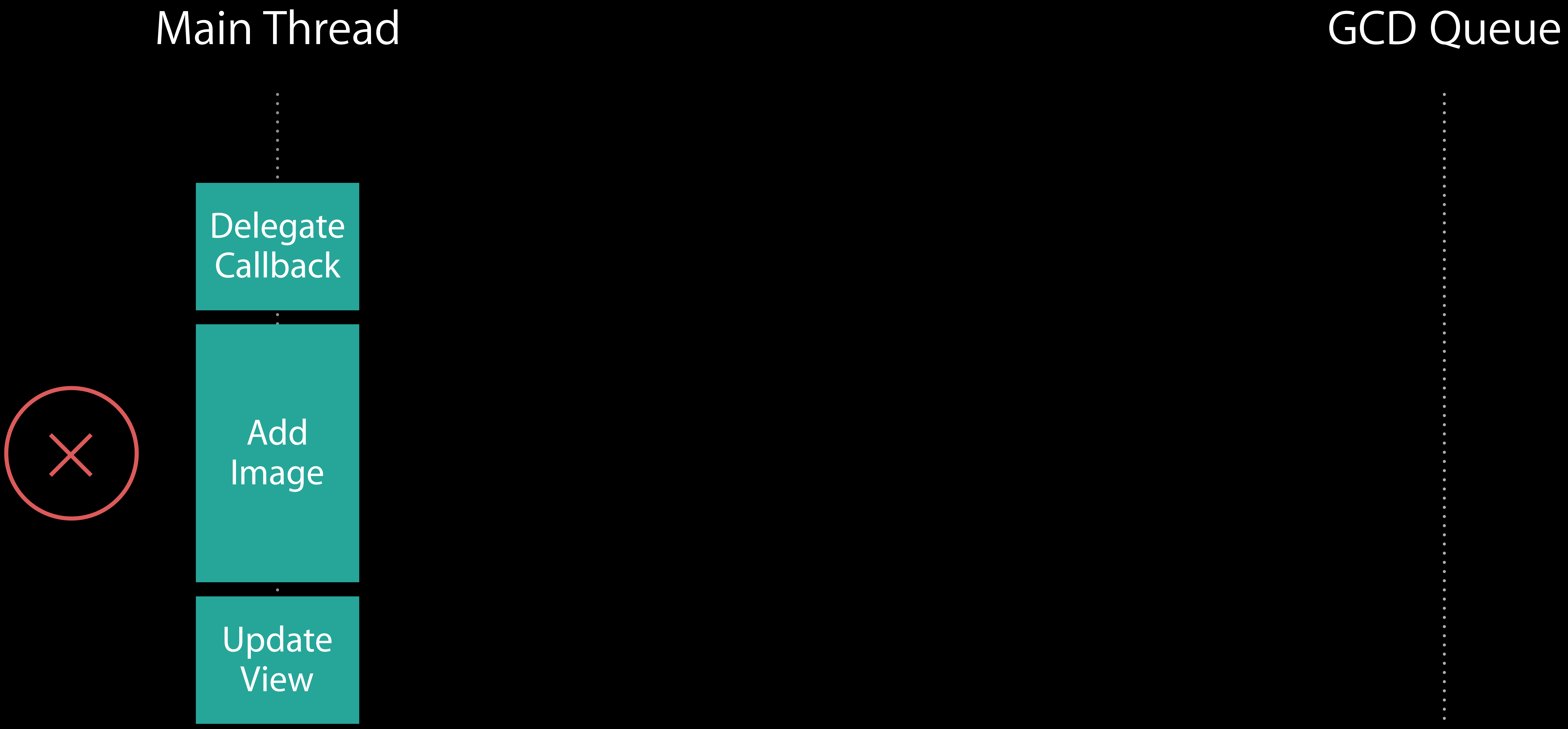

Main Thread

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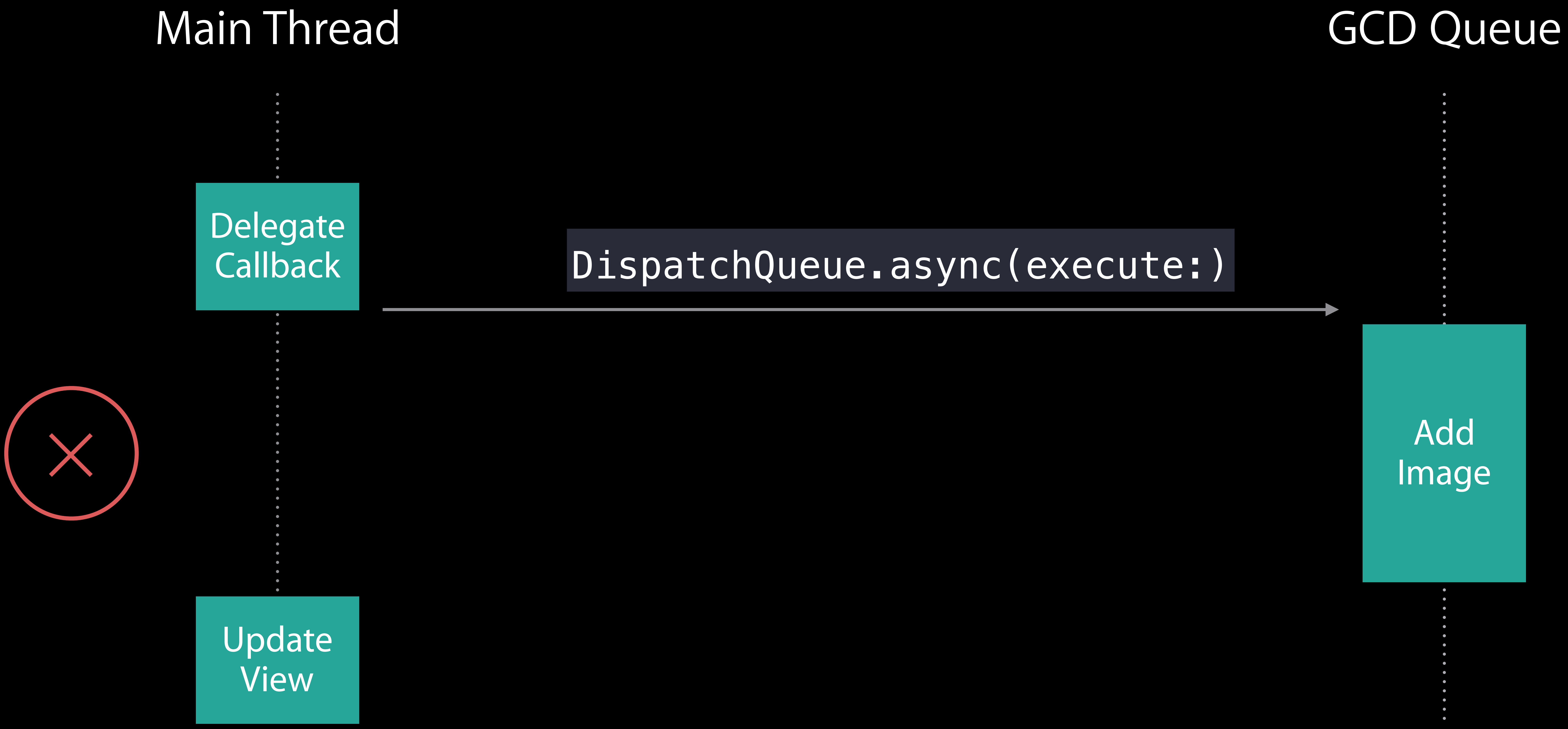

Main Thread

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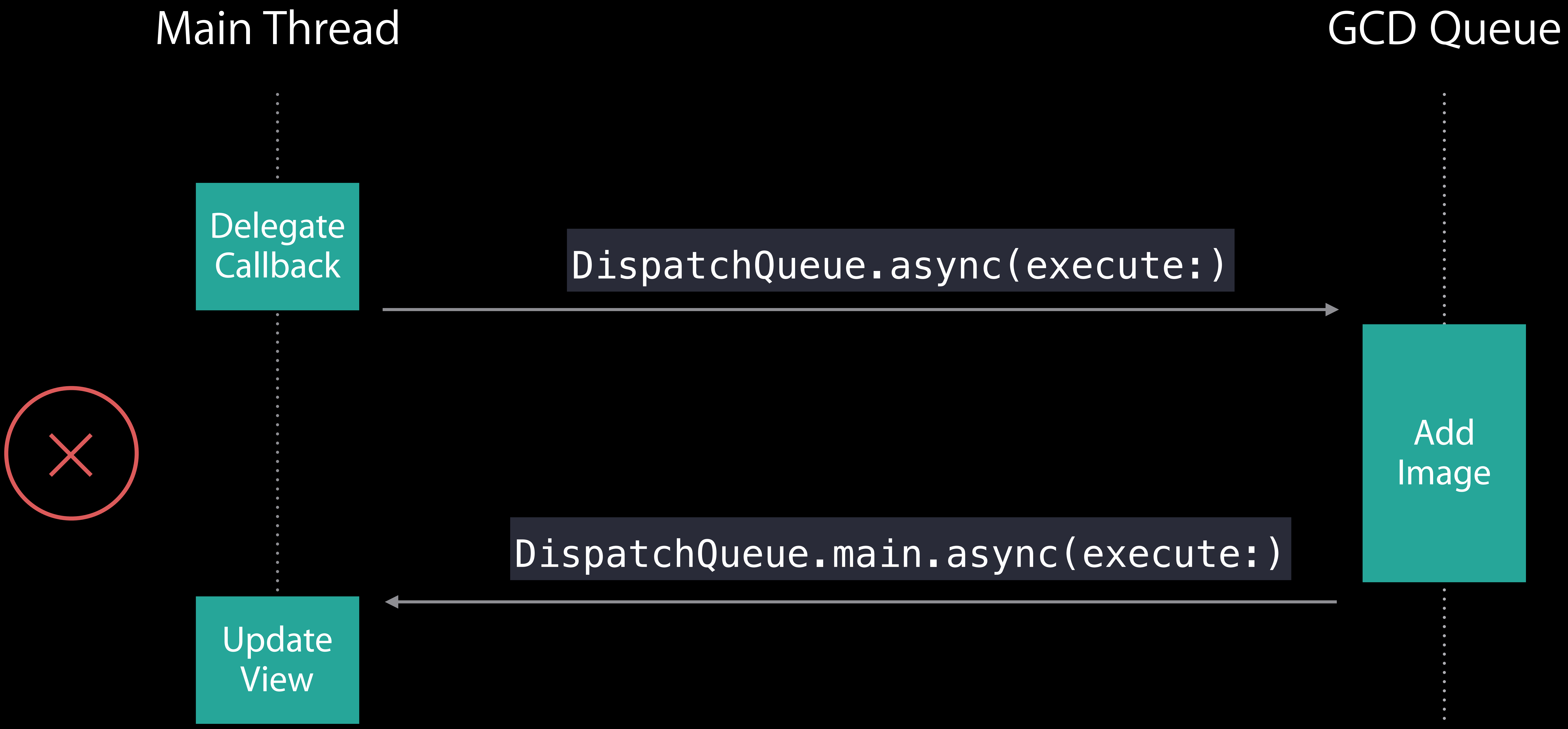
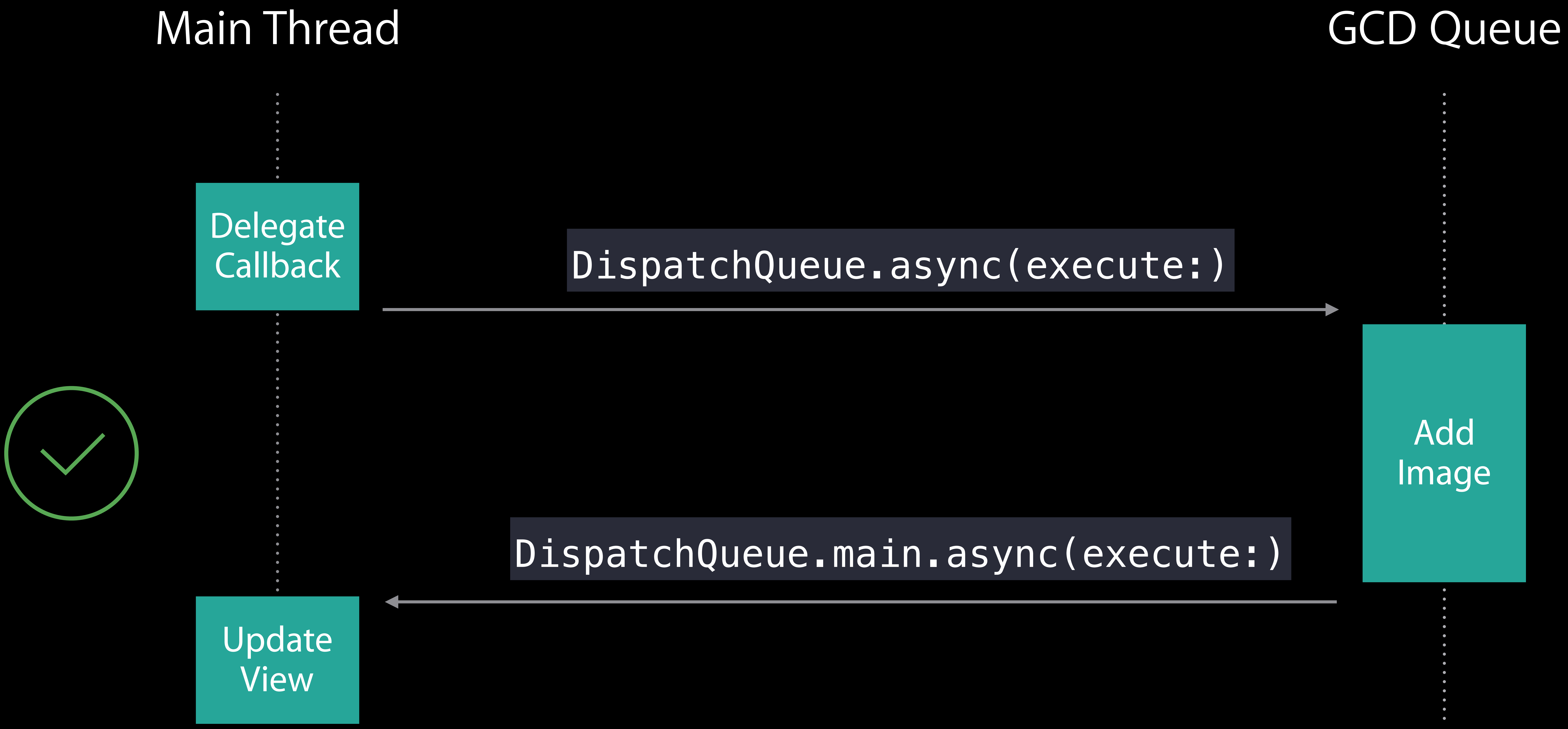

Main Thread
GCD Queue
Delegate Callback
DispatchQueue.async(execute:)
Add Image
DispatchQueue.main.async(execute:)
Update View

Main Thread

Responsive UI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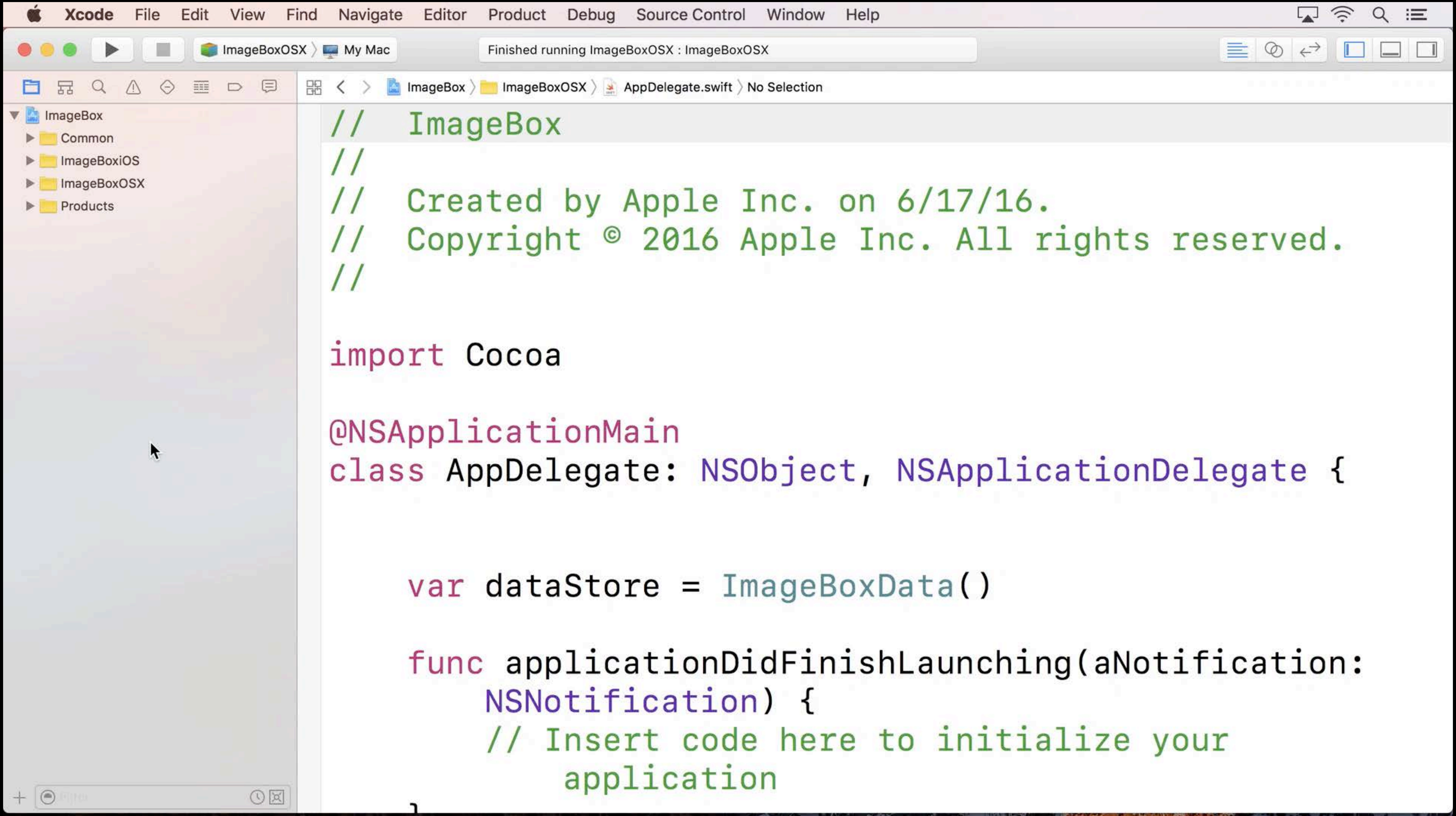

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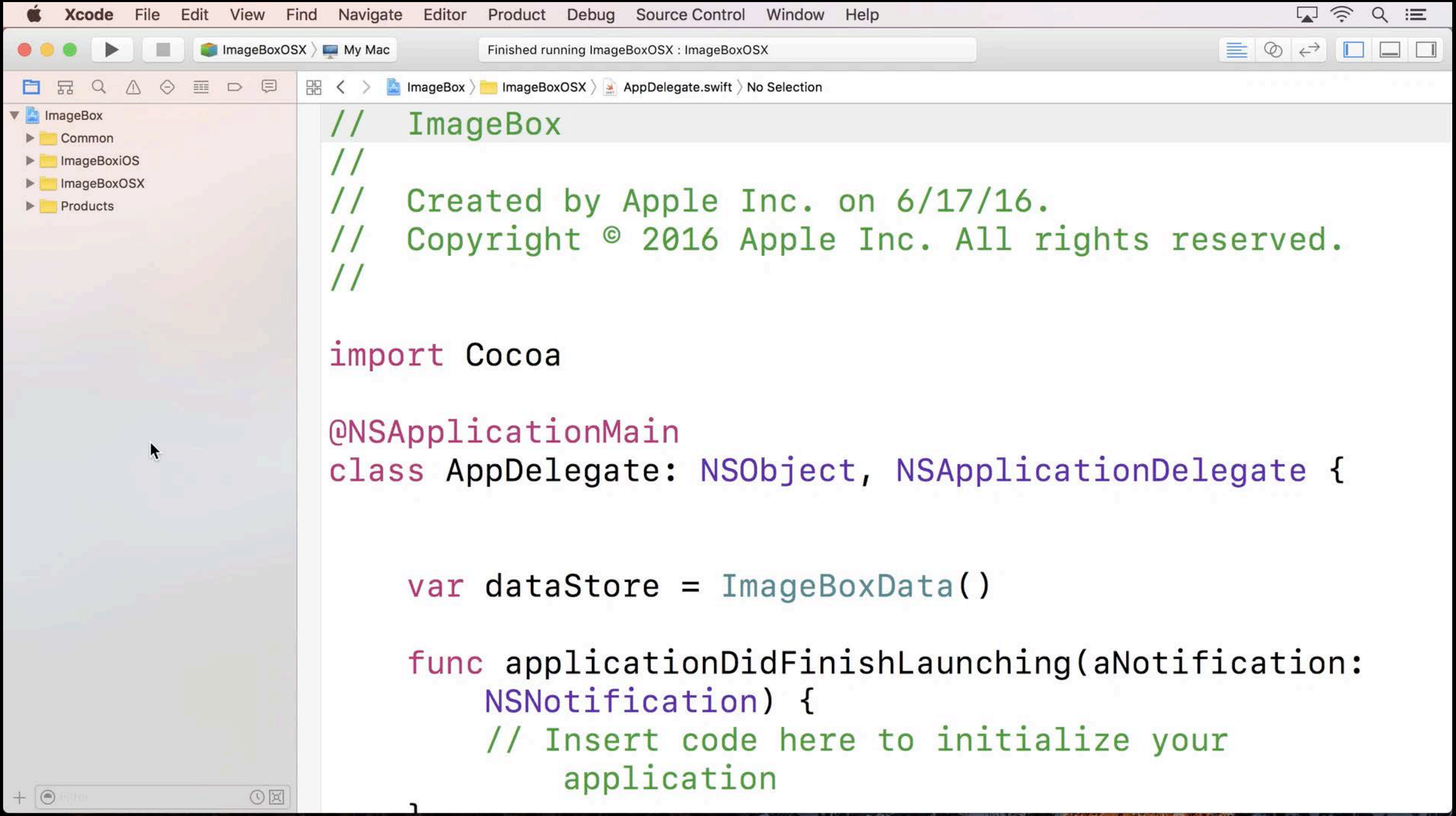

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Quality of Service

Quality of Service

Overview

Quality of Service
Overview

Management of system resources

Quality of Service

Overview

Management of system resources

Visibility, importance, expectation

Quality of Service

Overview

Management of system resources

Visibility, importance, expectation

- Is it visible?

Quality of Service
Overview

Management of system resources

Visibility, importance, expectation

- Is it visible?
- What is the importance?

Quality of Service

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Management of system resources

Visibility, importance, expectation

- Is it visible?
- What is the importance?
- How long is it expected to take?

Quality of Service
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Quality of Service

QoS	Description	Example

Quality of Service

	QoS	Description	Example
🟧	User Interactive	Main thread, animations	Scrolling

Quality of Service

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🟦	Utility	Long-running tasks	Rendering a movie

Quality of Service

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🟧	User Interactive	Main thread, animations	Scrolling
🟩	User Initiated	Immediate results	Switching to new view
🟦	Utility	Long-running tasks	Rendering a movie
🟪	Background	Not user visible	Indexing

Quality of Service

Specifying QoS

Quality of Service

Specifying QoS

```
// 1. Dispatch queue
let queue = DispatchQueue(label: "my queue")
queue.async(qos: .background) {
    // asynchronous code
}
```

Quality of Service

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let operation = Operation()
operation.qualityOfService = .utility
```

Quality of Service

Specifying QoS

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```

Quality of Service

ImageBox: Adding images

```
queue.async {
   guard let image = Image(contentsOf: url) else { return }
   let item = BoxItem(image: image)
   if self.dataStore.add(item) {
      DispatchQueue.main.async {
         self.collectionView?.reloadData()
      }
   }
}
```

Quality of Service

ImageBox: Adding images

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    guard let image = Image(contentsOf: url) else { return }
    let item = BoxItem(image: image)
    if self.dataStore.add(item) {
        DispatchQueue.main.async {
            self.collectionView?.reloadData()
        }
    }
}
```

Adopt Appropriate APIs

Asset Catalogs

Overview

Simple app resource management

Asset Catalogs

Overview

Simple app resource management

- App icon and launch image

Asset Catalogs

Overview

Simple app resource management

- App icon and launch image
- Device and scale variants

Asset Catalogs
Overview

Simple app resource management

- App icon and launch image
- Device and scale variants
- Sprite atlas *(SpriteKit)*

Asset Catalogs

Overview

Simple app resource management

- App icon and launch image
- Device and scale variants
- Sprite atlas *(SpriteKit)*
- On-demand resources

Asset Catalogs

Overview

Simple app resource management

- App icon and launch image
- Device and scale variants
- Sprite atlas *(SpriteKit)*
- On-demand resources
- Watch complications

Asset Catalogs

I/O benefits

Asset Catalogs

I/O benefits

Storage efficiency

Asset Catalogs

I/O benefits

Storage efficiency

- On-disk footprint

Asset Catalogs

I/O benefits

Storage efficiency

- On-disk footprint
- App slicing *(iOS)*

Asset Catalogs

I/O benefits

Storage efficiency

- On-disk footprint
- App slicing *(iOS)*

Performance

Asset Catalogs

I/O benefits

Storage efficiency

- On-disk footprint
- App slicing *(iOS)*

Performance

- Image loading

Asset Catalogs

I/O benefits

Storage efficiency

- On-disk footprint
- App slicing *(iOS)*

Performance

- Image loading
- Texture rendering *(SpriteKit)*

Asset Catalogs

I/O benefits

Storage efficiency

- On-disk footprint
- App slicing *(iOS)*

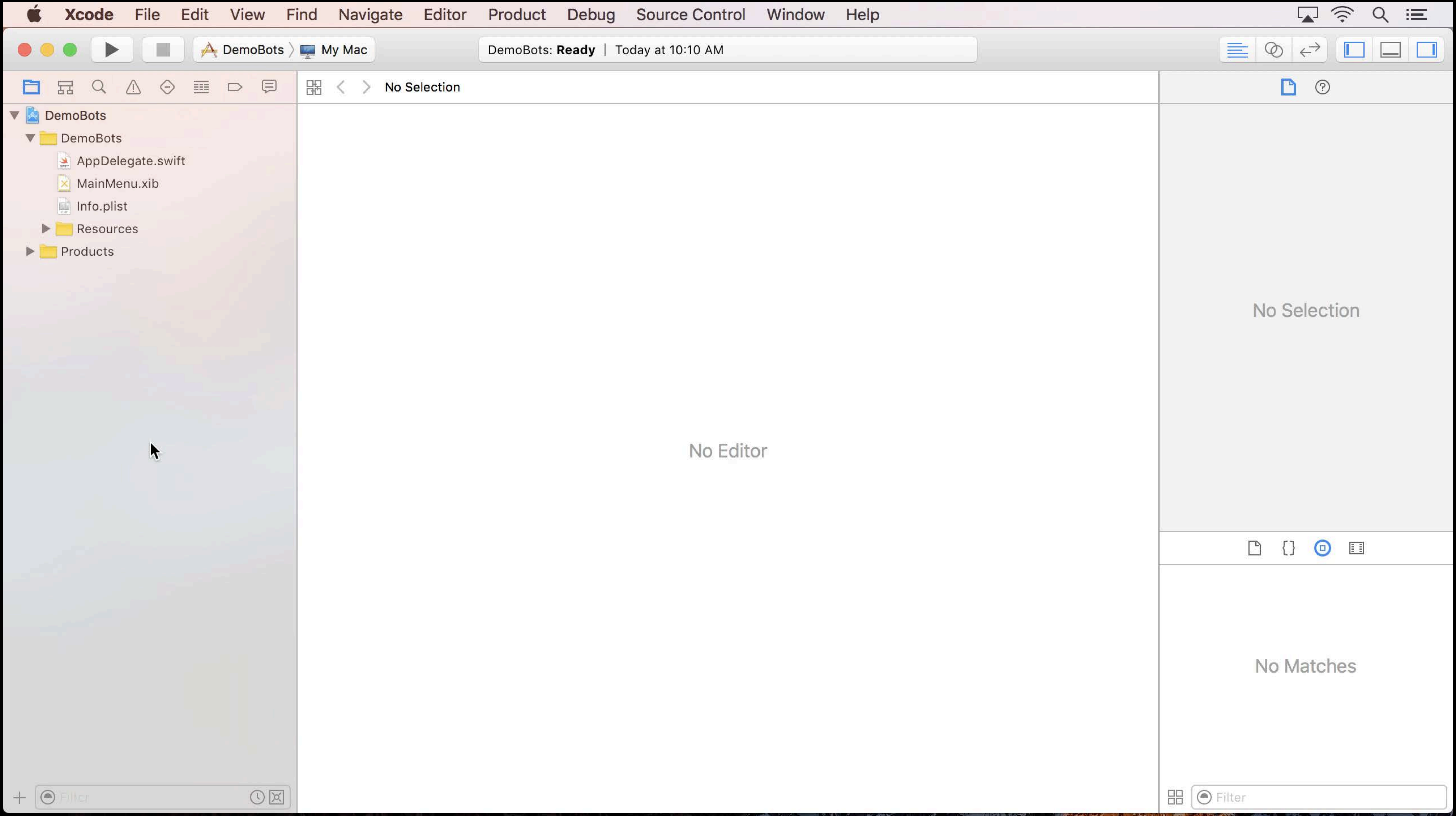
Performance

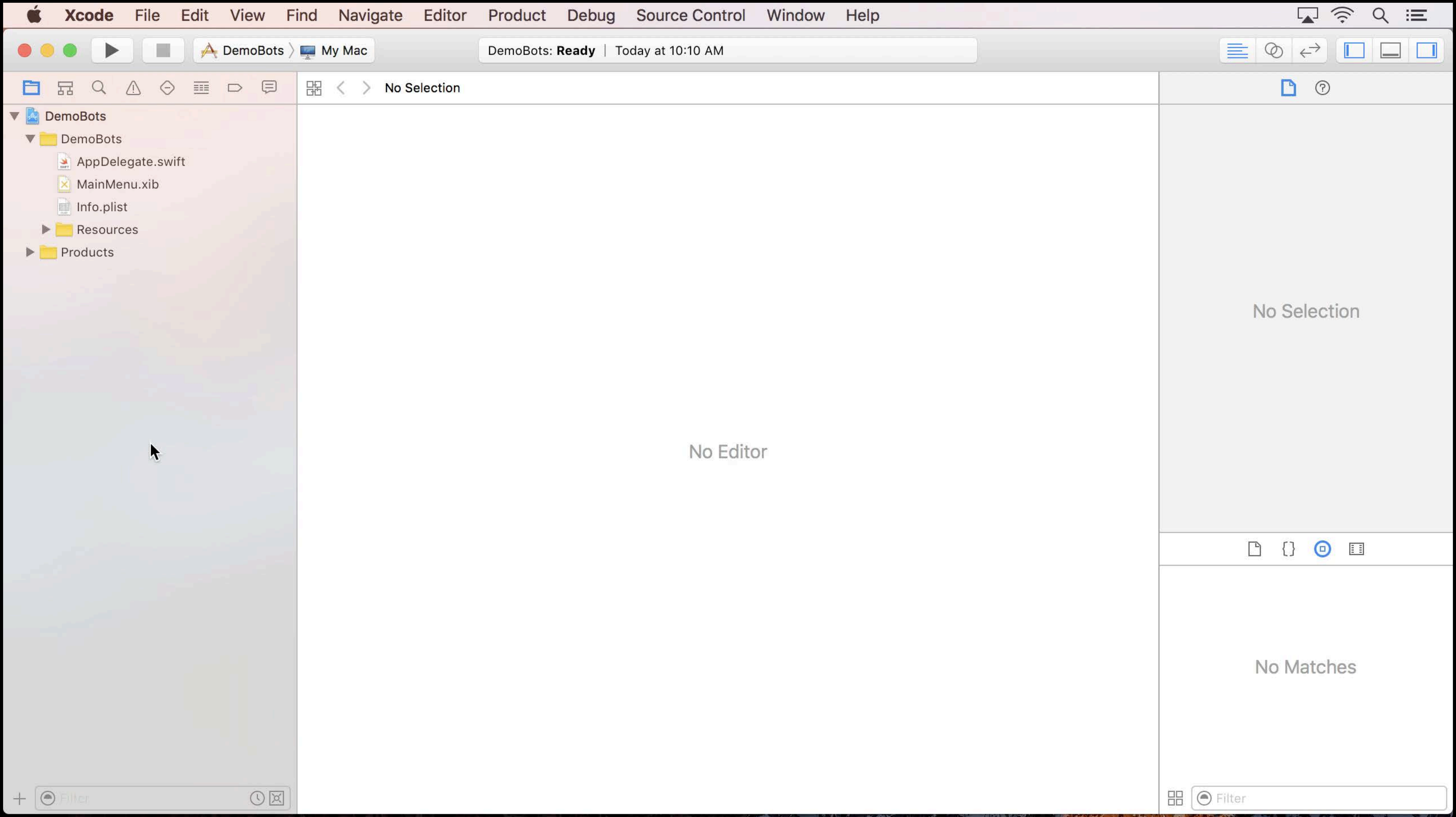
- Image loading
- Texture rendering *(SpriteKit)*
- App launch

HDD app launch improvement

10%

HDD app launch improvement


Xcode
File
Edit
View
Find
Navigate
Editor
Product
Debug
Source Control
Window
Help
DemoBots
My Mac
DemoBots: Ready | Today at 10:10 AM
No Selection
DemoBots
DemoBots
AppDelegate.swift
MainMenu.xib
Info.plist
Resources
Products
No Editor
No Selection
No Matches
Filter


Xcode
File
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Source Control
Window
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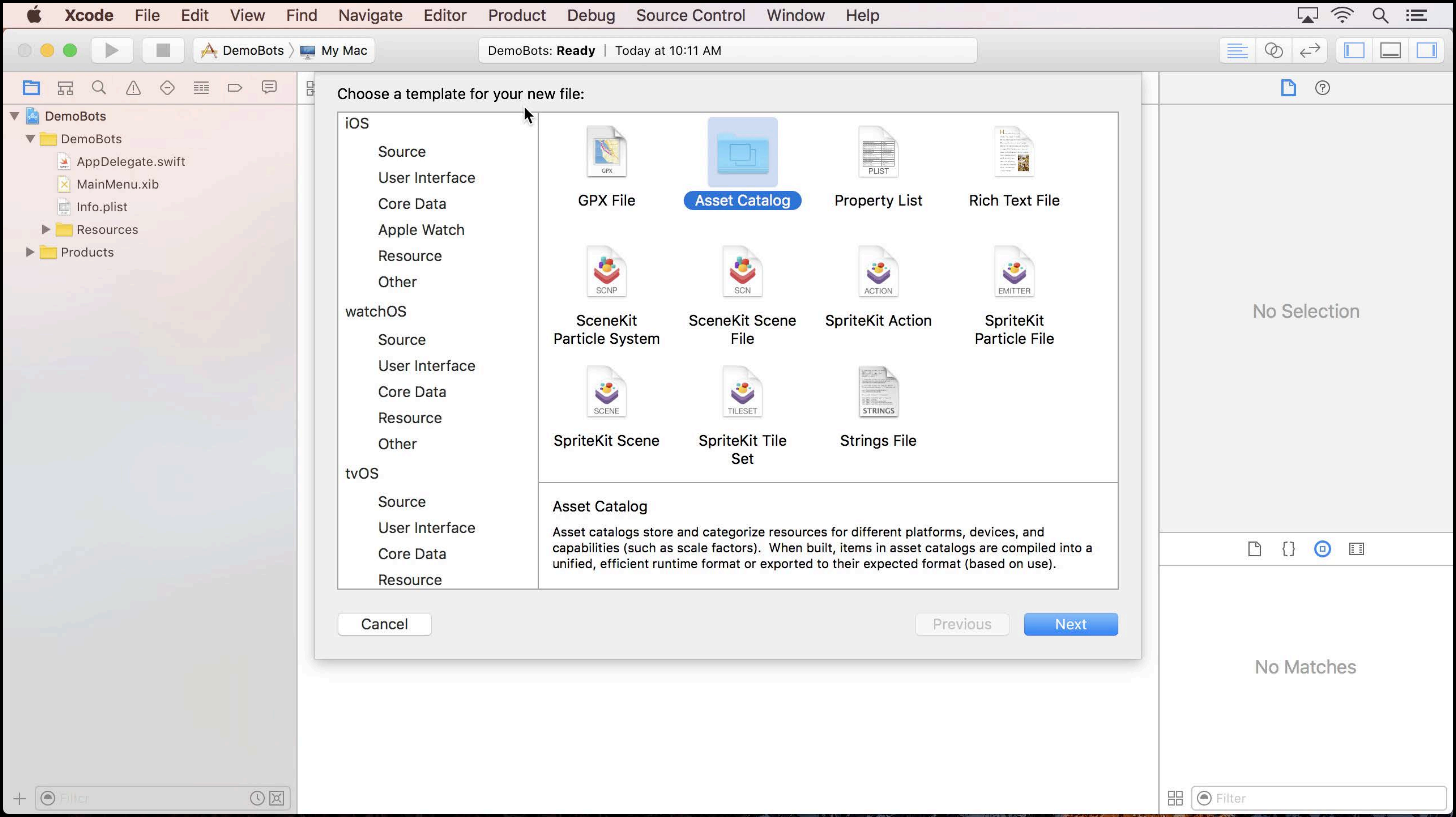
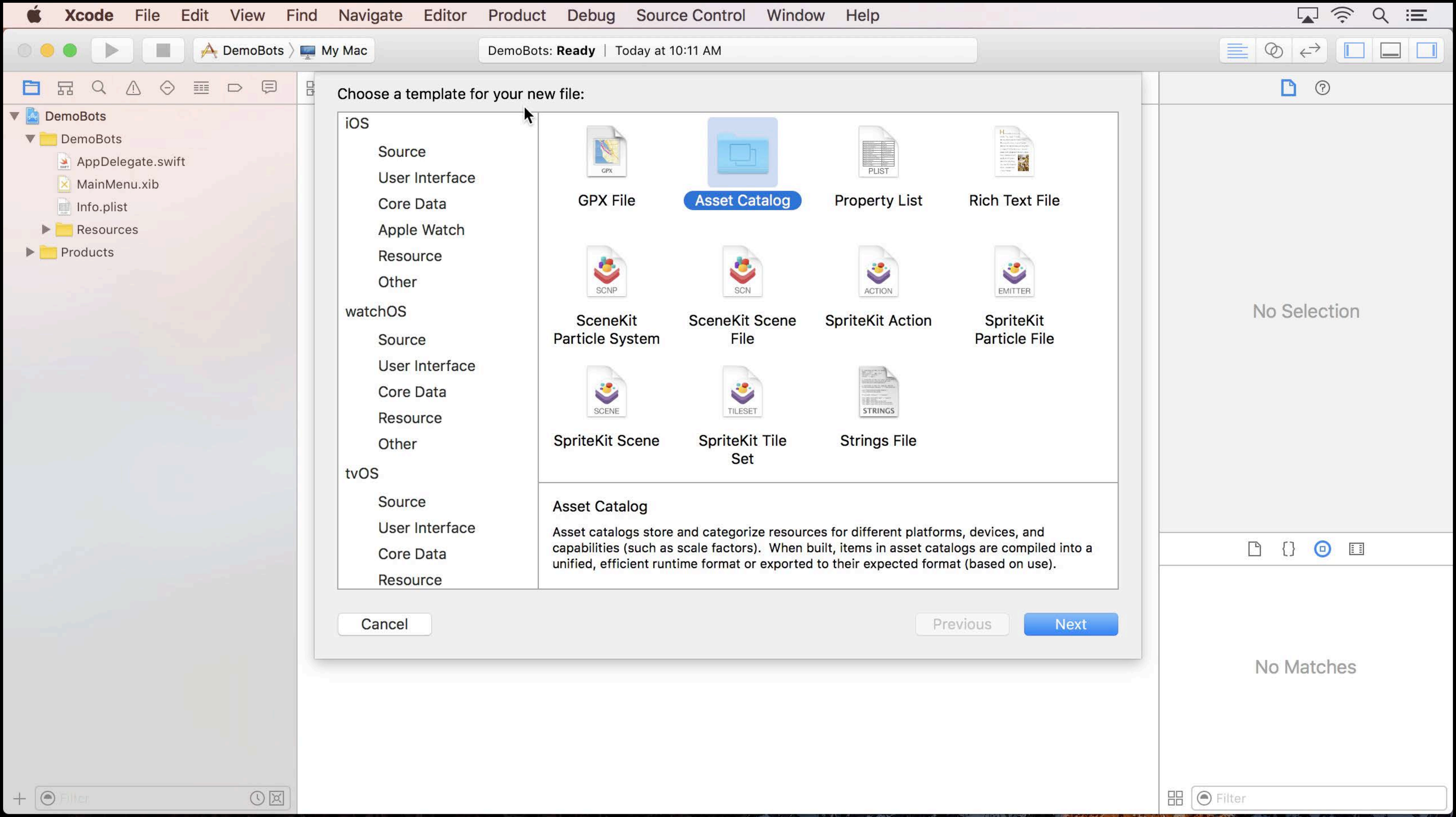


Choose a template for your new file:

Asset Catalog

Asset catalogs store and categorize resources for different platforms, devices, and capabilities (such as scale factors). When built, items in asset catalogs are compiled into a unified, efficient runtime format or exported to their expected format (based on use).


Xcode File Edit View Find Navigate Editor Product Debug Source Control Window Help
DemoBots My Mac
DemoBots: Ready | Today at 10:11 AM
DemoBots
DemoBots
AppDelegate.swift
MainMenu.xib
Info.plist
Resources
Products
No Selection
No Matches
Filter

Choose a template for your new file:

iOS
- Source
- User Interface
- Core Data
- Apple Watch
- Resource
- Other

watchOS
- Source
- User Interface
- Core Data
- Resource
- Other

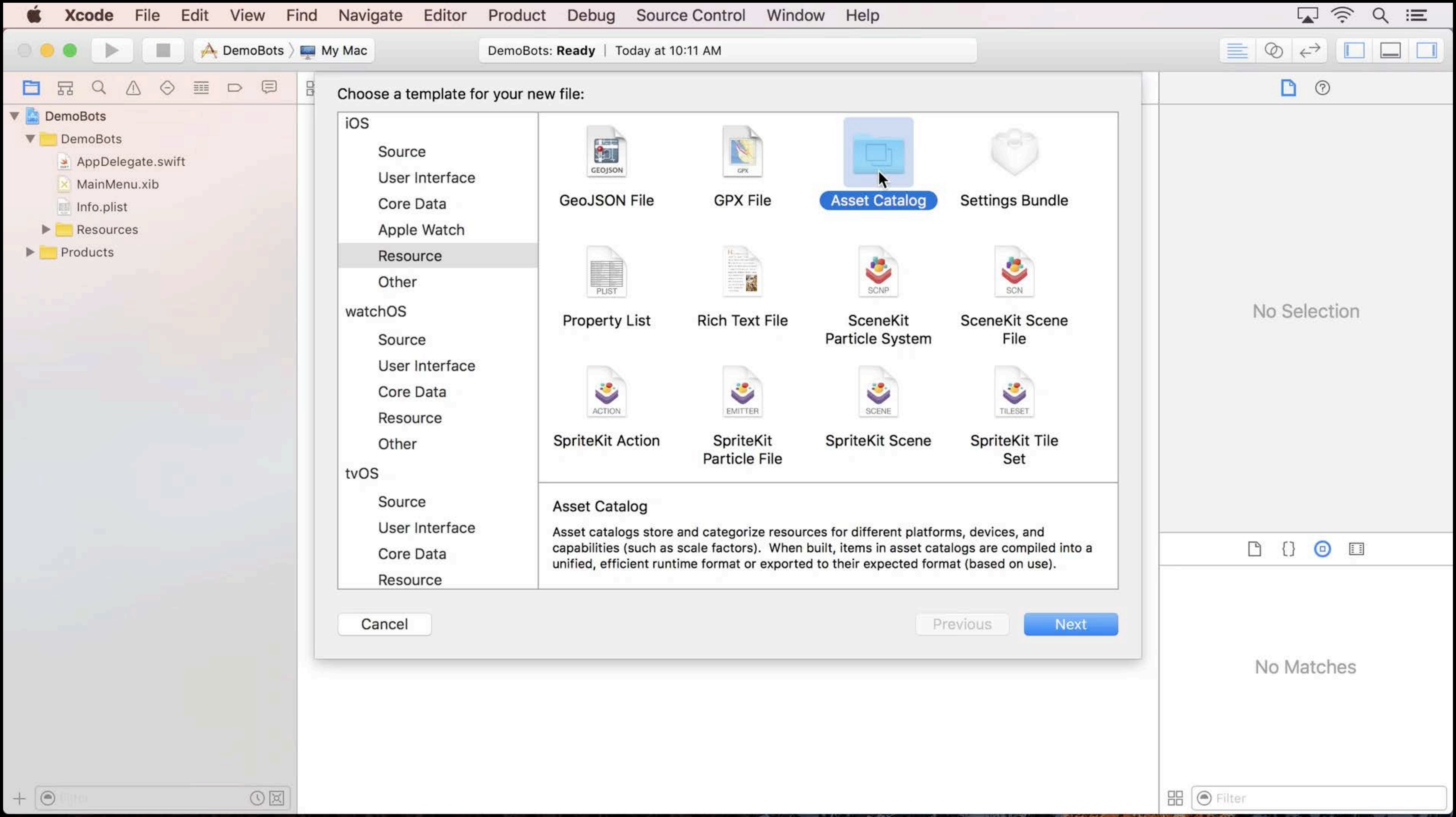
tvOS
- Source
- User Interface
- Core Data
- Resource

GPX File | Asset Catalog | Property List | Rich Text File | SceneKit Particle System | SceneKit Scene File | SpriteKit Action | SpriteKit Particle File | SpriteKit Scene | SpriteKit Tile Set | Strings File

Asset Catalog

Asset catalogs store and categorize resources for different platforms, devices, and capabilities (such as scale factors). When built, items in asset catalogs are compiled into a unified, efficient runtime format or exported to their expected format (based on use).

Cancel | Previous | Next



Asset Catalog

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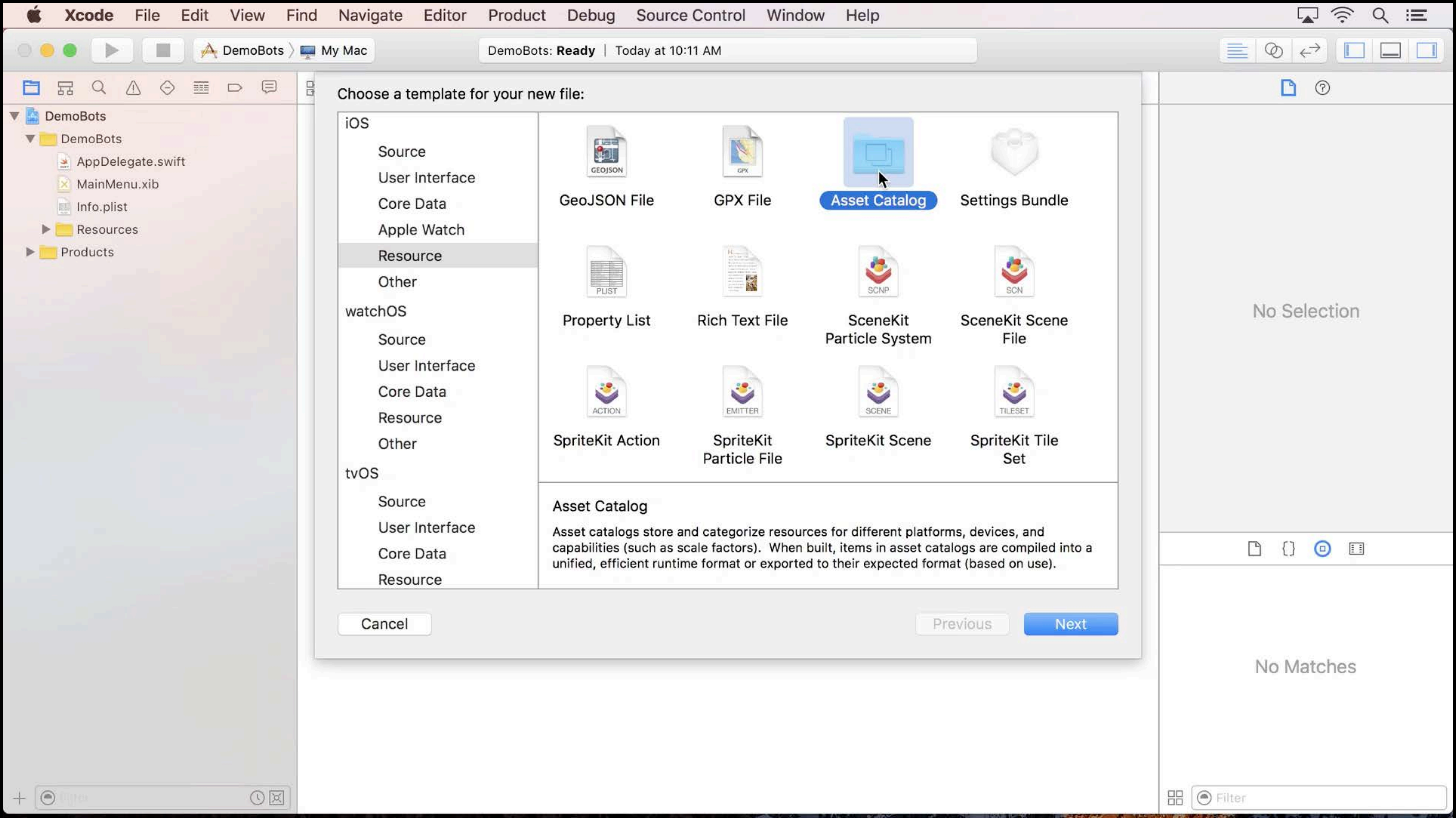

Choose a template for your new file:

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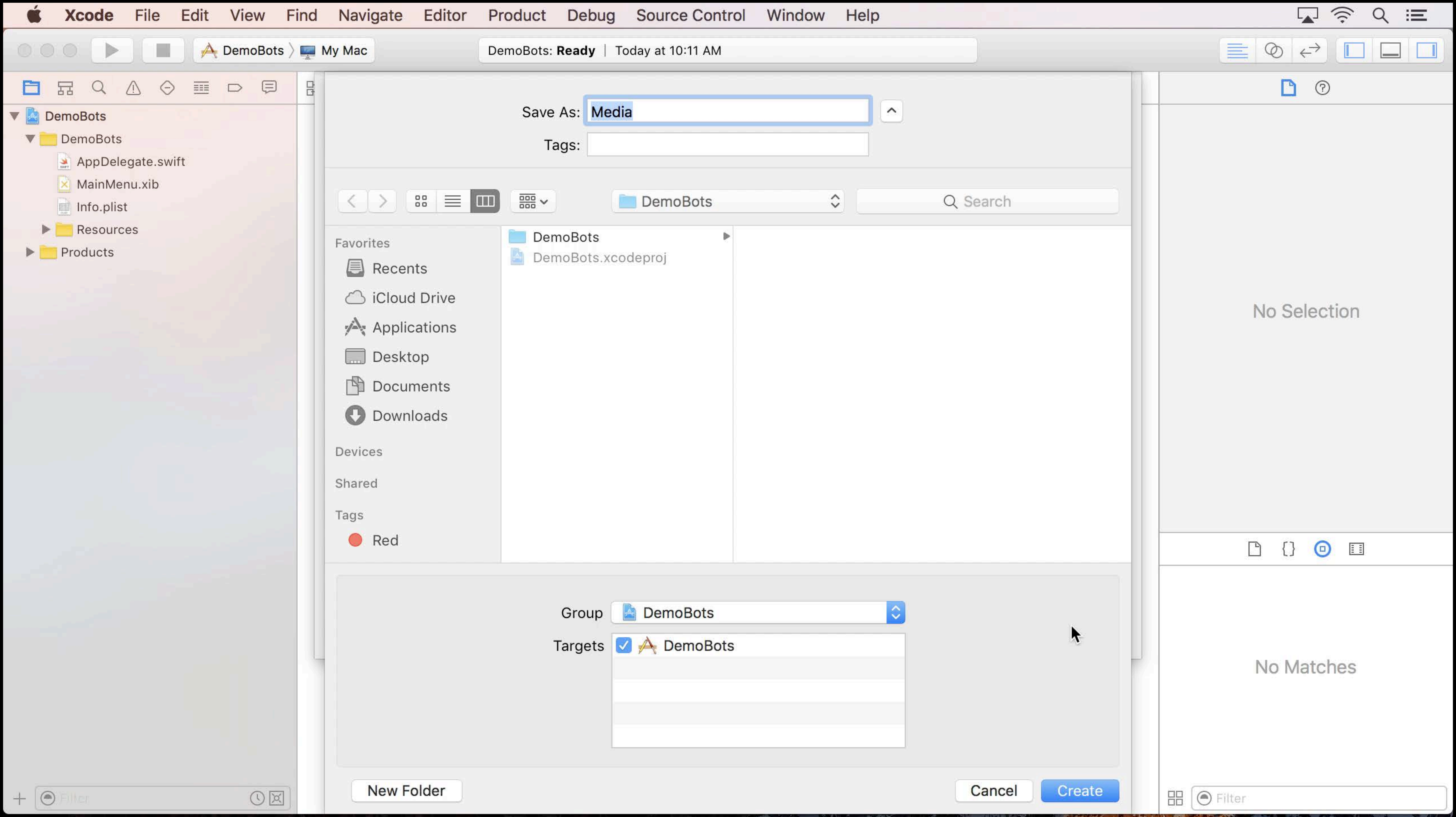
Xcode
File
Edit
View
Find
Navigate
Editor
Product
Debug
Source Control
Window
Help
DemoBots
My Mac
DemoBots: Ready | Today at 10:11 AM
DemoBots
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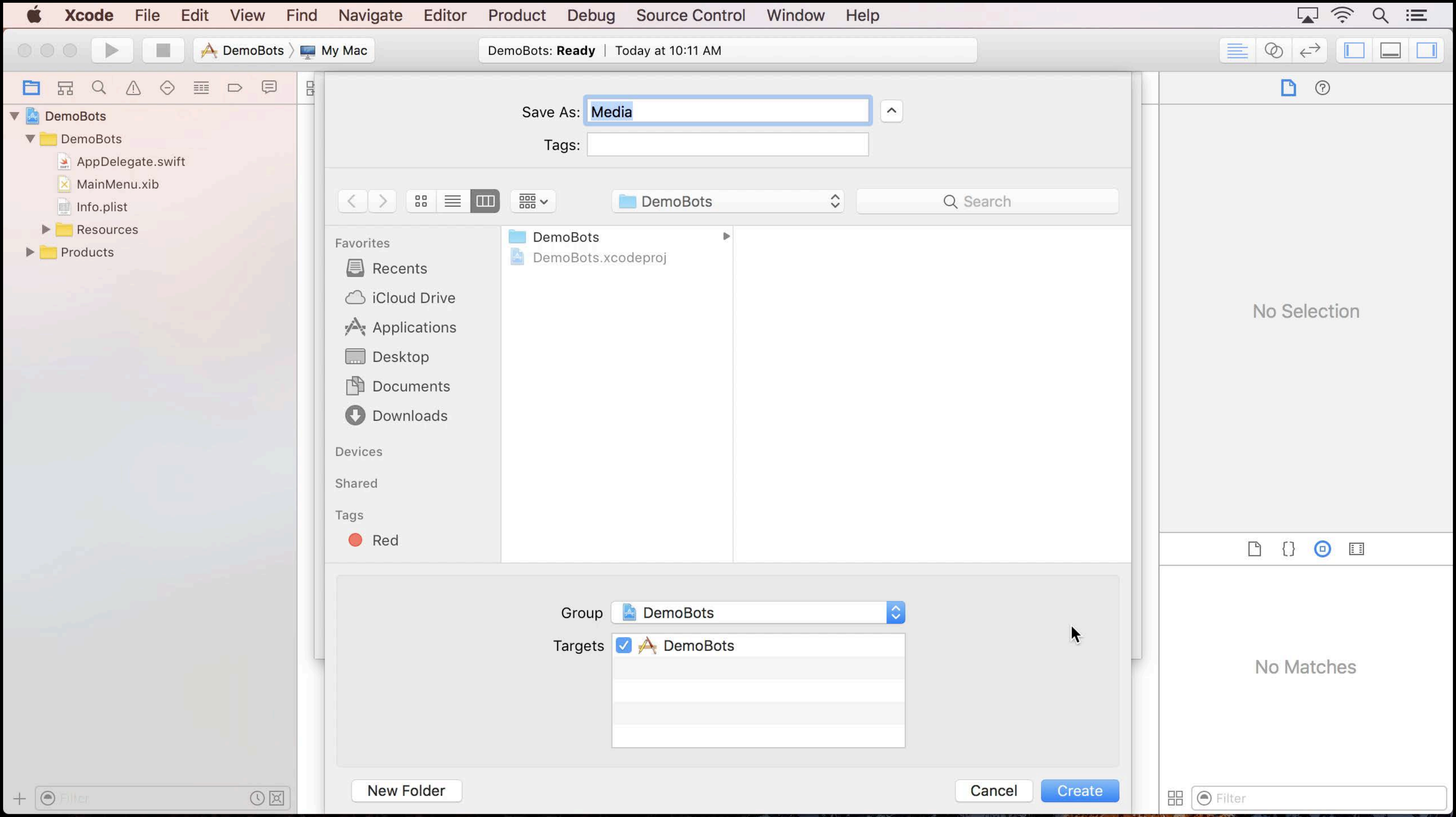
Save As: Media
Tags:
DemoBots
Search
Favorites
Recents
iCloud Drive
Applications
Desktop
Documents
Downloads
Devices
Shared
Tags
Red
DemoBots
DemoBots.xcodeproj
Group DemoBots
Targets DemoBots
New Folder
Cancel
Create
No Selection
No Matches
Filter



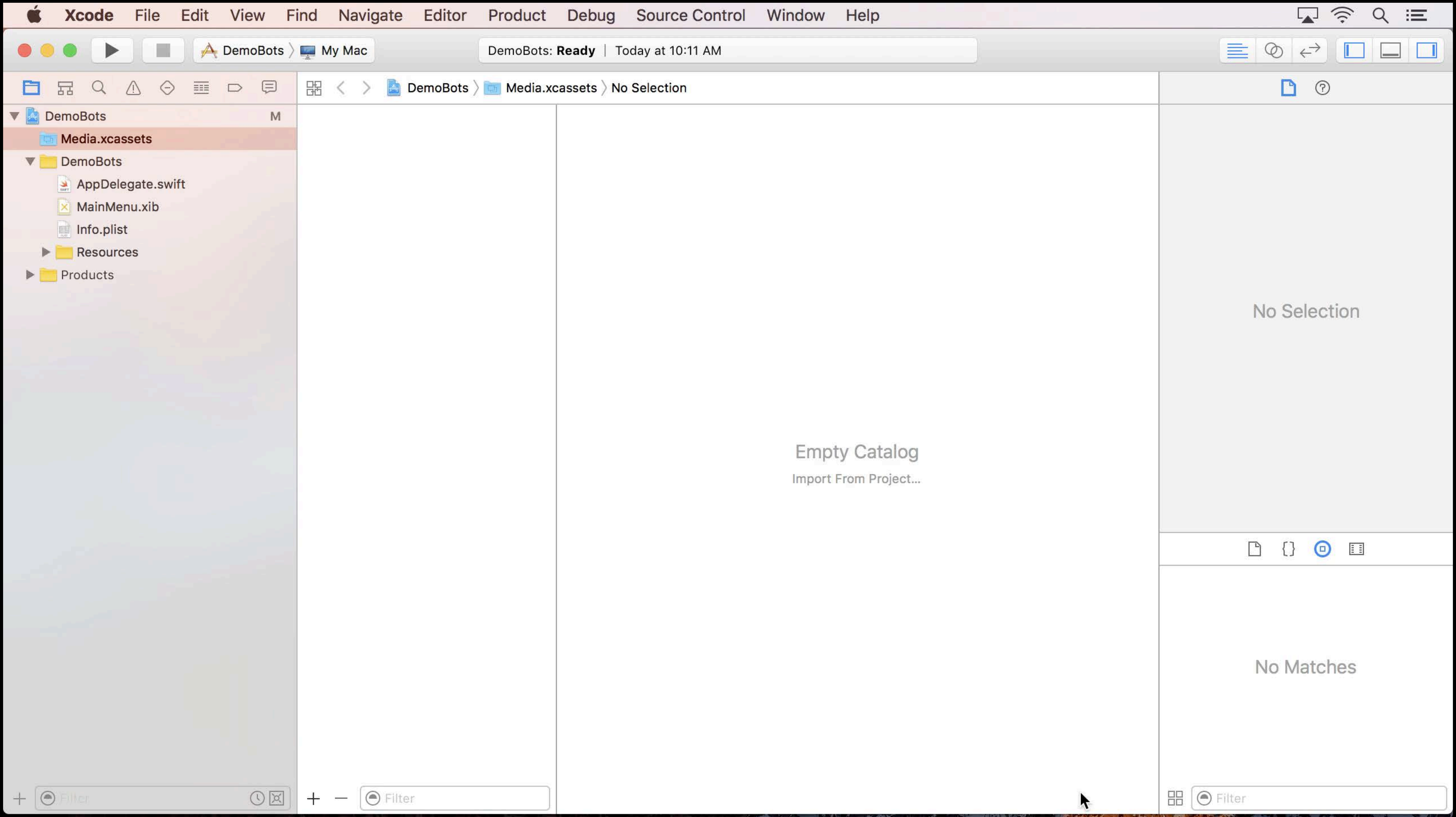
Save As: Media

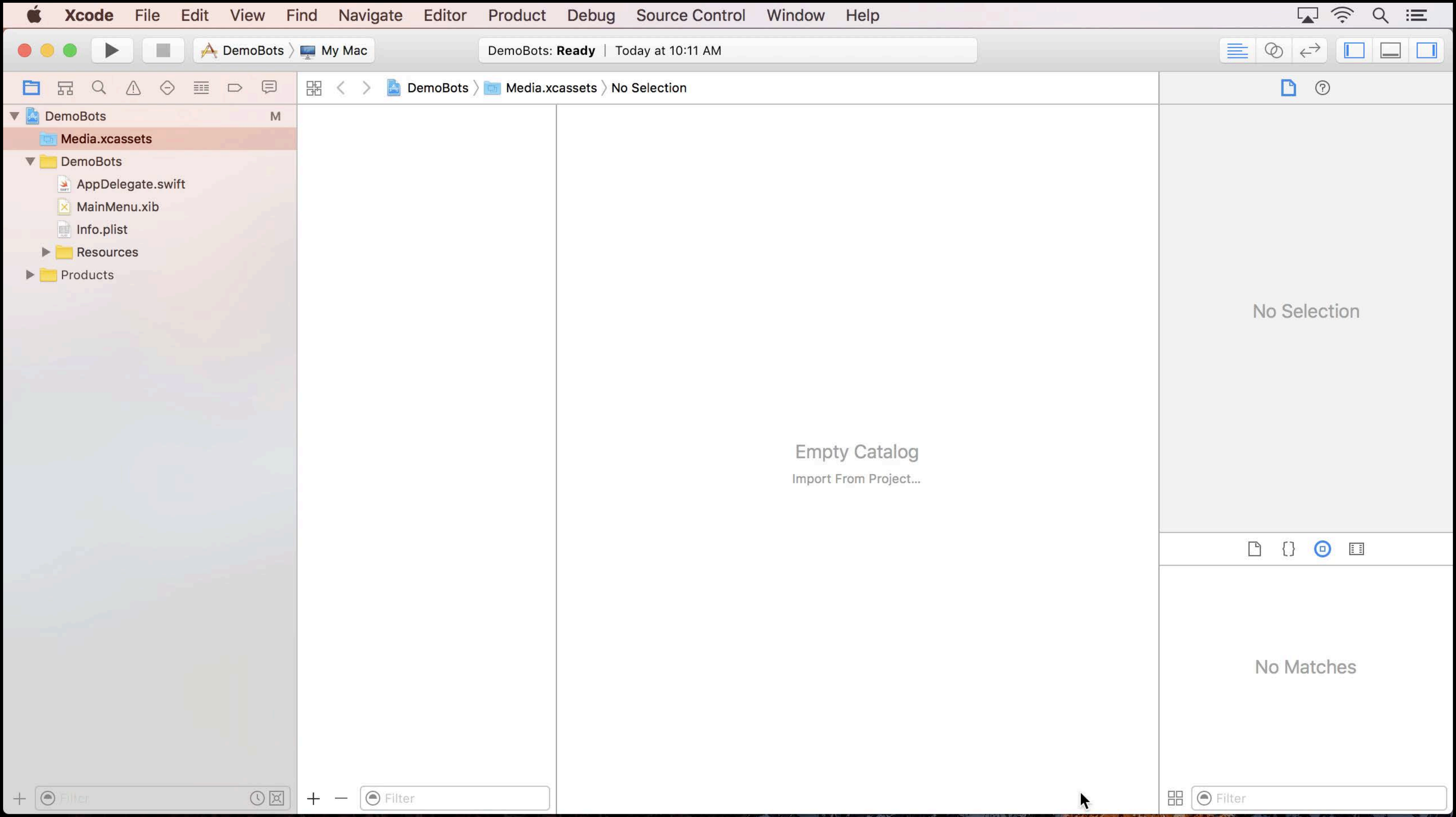
Tags:

DemoBots

Group DemoBots

Targets ✓ DemoBots


Xcode
File
Edit
View
Find
Navigate
Editor
Product
Debug
Source Control
Window
Help
DemoBots
My Mac
DemoBots: Ready | Today at 10:11 AM
DemoBots
Media.xcassets
No Selection
DemoBots M
Media.xcassets
DemoBots
AppDelegate.swift
MainMenu.xib
Info.plist
Resources
Products
Empty Catalog
Import From Project...
No Selection
No Matches
Filter
Filter
Filter


Xcode File Edit View Find Navigate Editor Product Debug Source Control Window Help
DemoBots › My Mac
DemoBots: Ready | Today at 10:11 AM
DemoBots › Media.xcassets › No Selection
DemoBots M
Media.xcassets
DemoBots
AppDelegate.swift
MainMenu.xib
Info.plist
Resources
Products
Empty Catalog
Import From Project...
No Selection
No Matches
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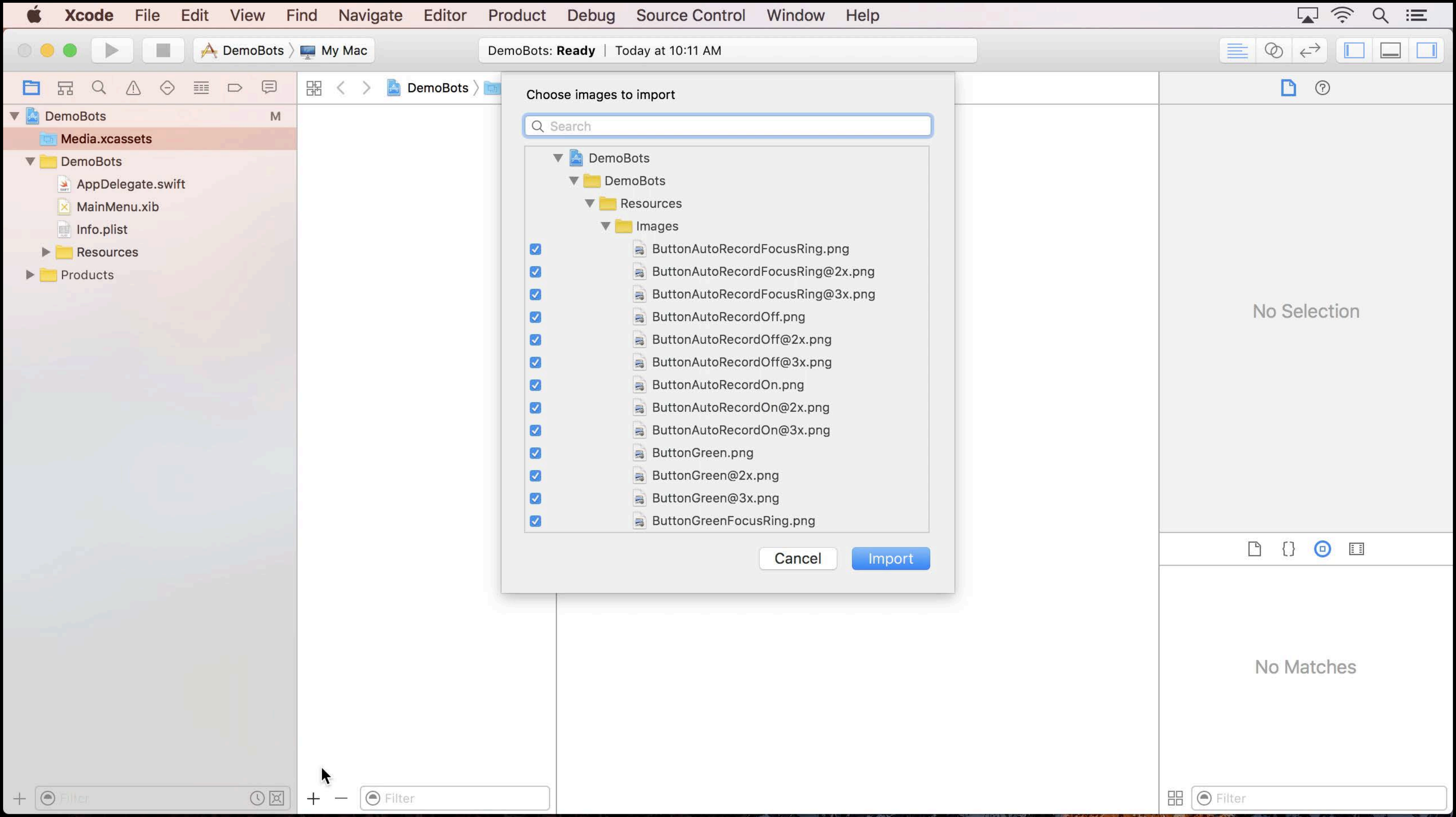
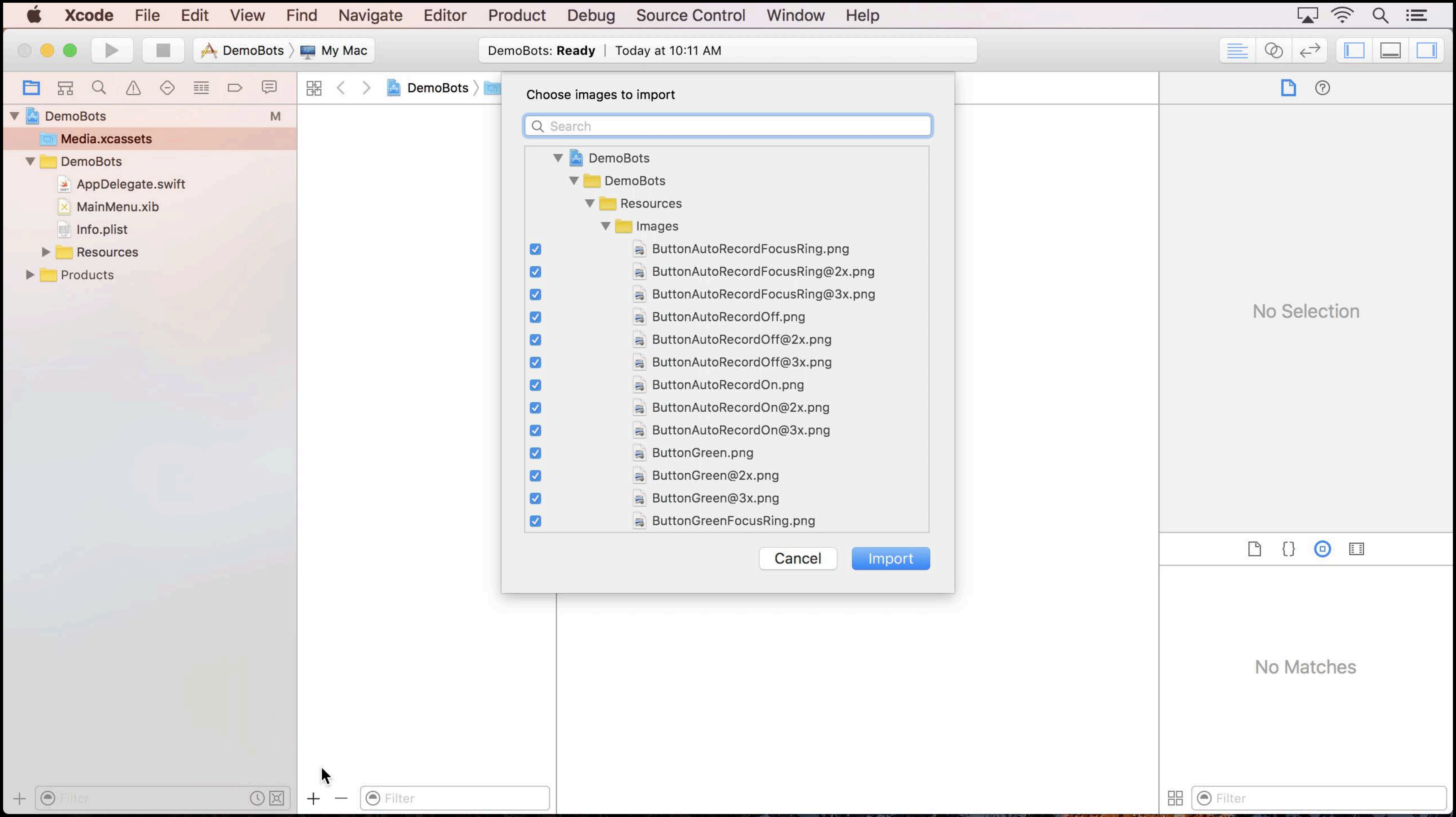


Choose images to import

Search

- DemoBots
  - DemoBots
    - Resources
      - Images
        - [✓] ButtonAutoRecordFocusRing.png
        - [✓] ButtonAutoRecordFocusRing@2x.png
        - [✓] ButtonAutoRecordFocusRing@3x.png
        - [✓] ButtonAutoRecordOff.png
        - [✓] ButtonAutoRecordOff@2x.png
        - [✓] ButtonAutoRecordOff@3x.png
        - [✓] ButtonAutoRecordOn.png
        - [✓] ButtonAutoRecordOn@2x.png
        - [✓] ButtonAutoRecordOn@3x.png
        - [✓] ButtonGreen.png
        - [✓] ButtonGreen@2x.png
        - [✓] ButtonGreen@3x.png
        - [✓] ButtonGreenFocusRing.png

Cancel Import



Choose images to import

Search

- DemoBots
  - DemoBots
    - Resources
      - Images
        - ButtonAutoRecordFocusRing.png
        - ButtonAutoRecordFocusRing@2x.png
        - ButtonAutoRecordFocusRing@3x.png
        - ButtonAutoRecordOff.png
        - ButtonAutoRecordOff@2x.png
        - ButtonAutoRecordOff@3x.png
        - ButtonAutoRecordOn.png
        - ButtonAutoRecordOn@2x.png
        - ButtonAutoRecordOn@3x.png
        - ButtonGreen.png
        - ButtonGreen@2x.png
        - ButtonGreen@3x.png
        - ButtonGreenFocusRing.png

Asset Catalogs

Image compression

NEW

Asset Catalogs

Image compression

NEW

Lossless by default

Asset Catalogs

Image compression

NEW

Lossless by default

Lossy image compression available

Asset Catalogs

Image compression

NEW

Lossless by default

Lossy image compression available

- Hardware accelerated decompression

Asset Catalogs

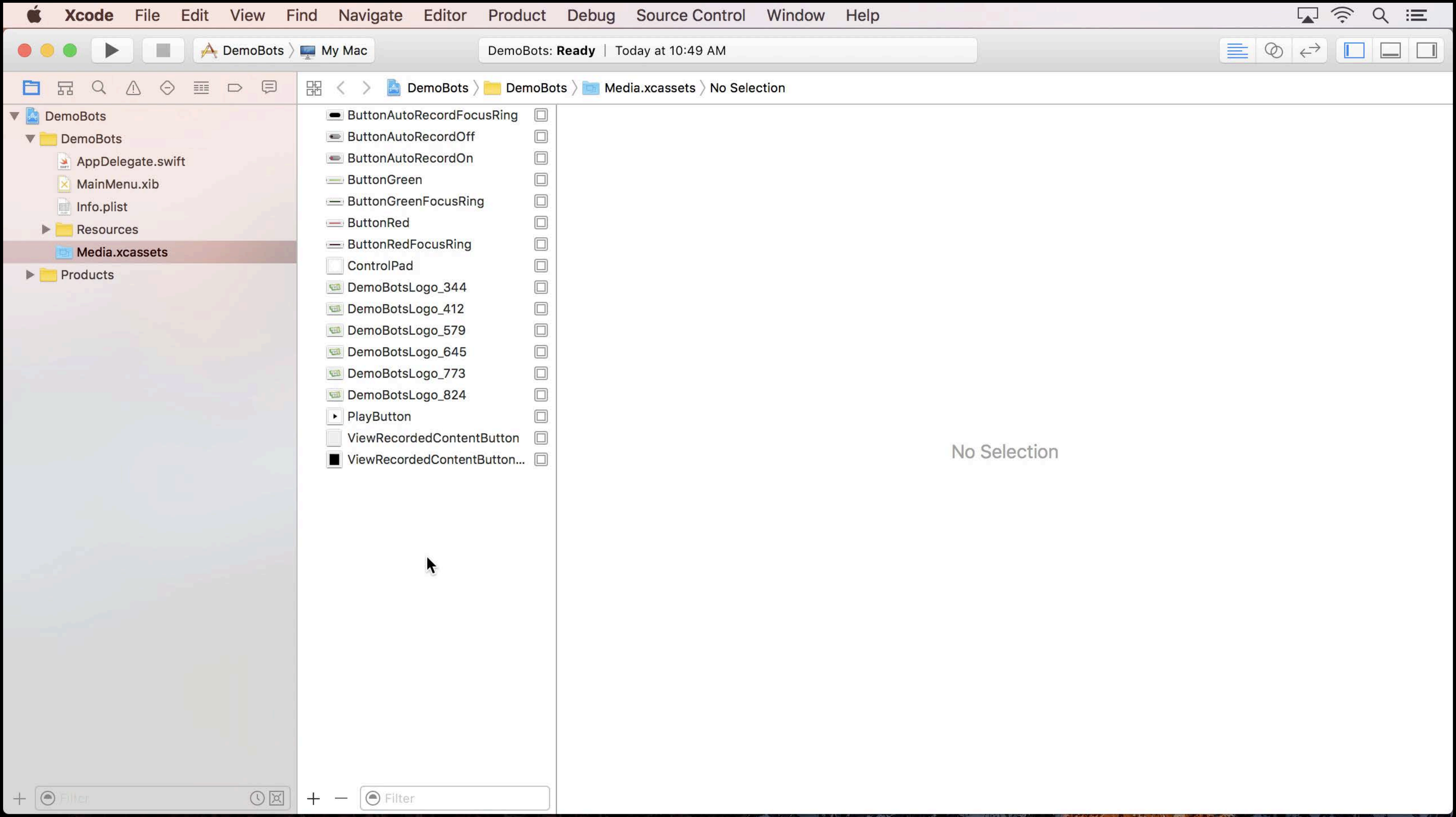
Image compression

NEW

Lossless by default

Lossy image compression available

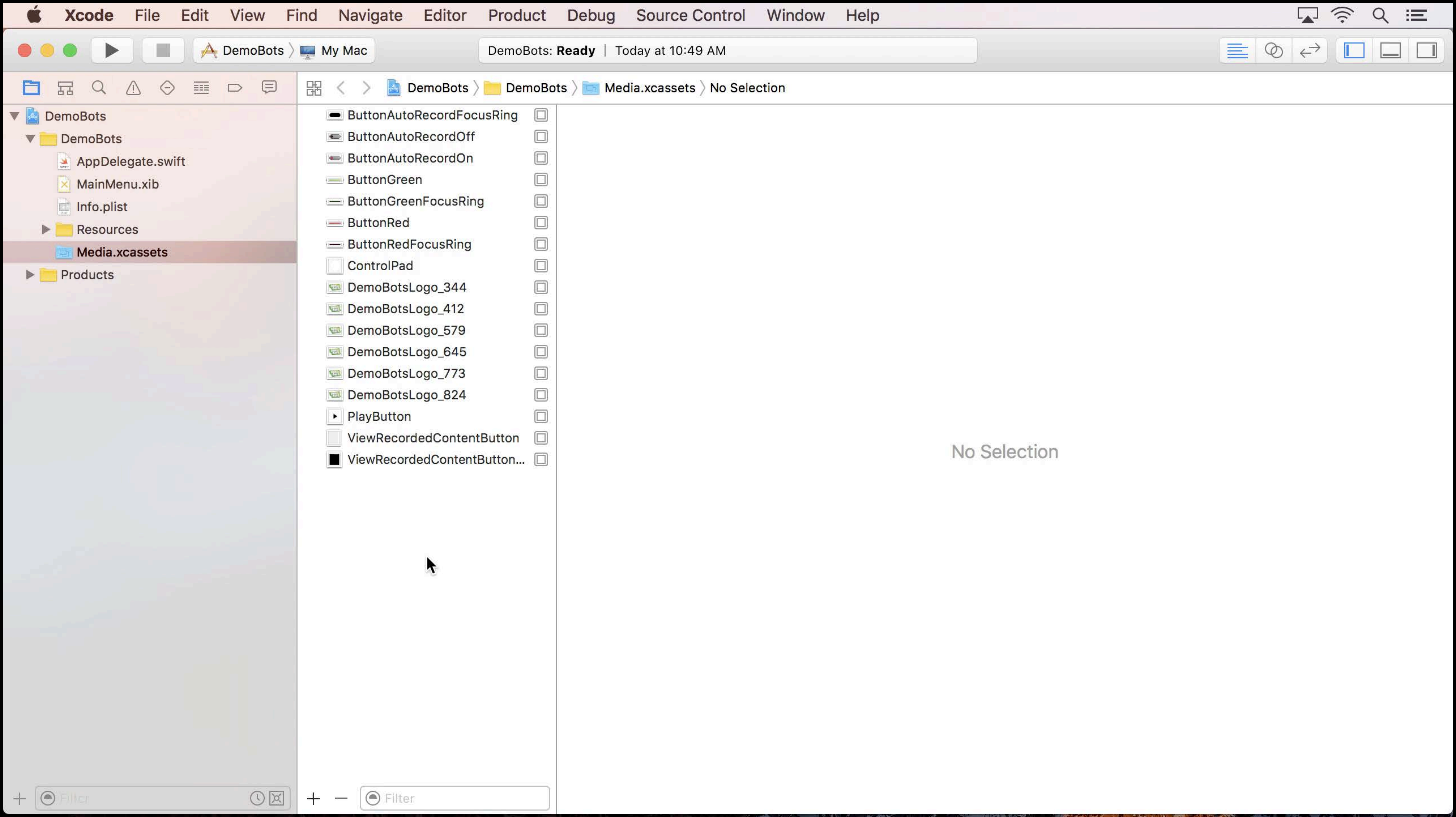
- Hardware accelerated decompression
- Lower memory footprint



DemoBots
DemoBots
AppDelegate.swift
MainMenu.xib
Info.plist
Resources
Media.xcassets
Products

ButtonAutoRecordFocusRing
ButtonAutoRecordOff
ButtonAutoRecordOn
ButtonGreen
ButtonGreenFocusRing
ButtonRed
ButtonRedFocusRing
ControlPad
DemoBotsLogo_344
DemoBotsLogo_412
DemoBotsLogo_579
DemoBotsLogo_645
DemoBotsLogo_773
DemoBotsLogo_824
PlayButton
ViewRecordedContentButton
ViewRecordedContentButton...

No Selection


Xcode File Edit View Find Navigate Editor Product Debug Source Control Window Help
DemoBots My Mac
DemoBots: Ready | Today at 10:49 AM
DemoBots DemoBots Media.xcassets No Selection
DemoBots
DemoBots
AppDelegate.swift
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Info.plist
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Media.xcassets
Products
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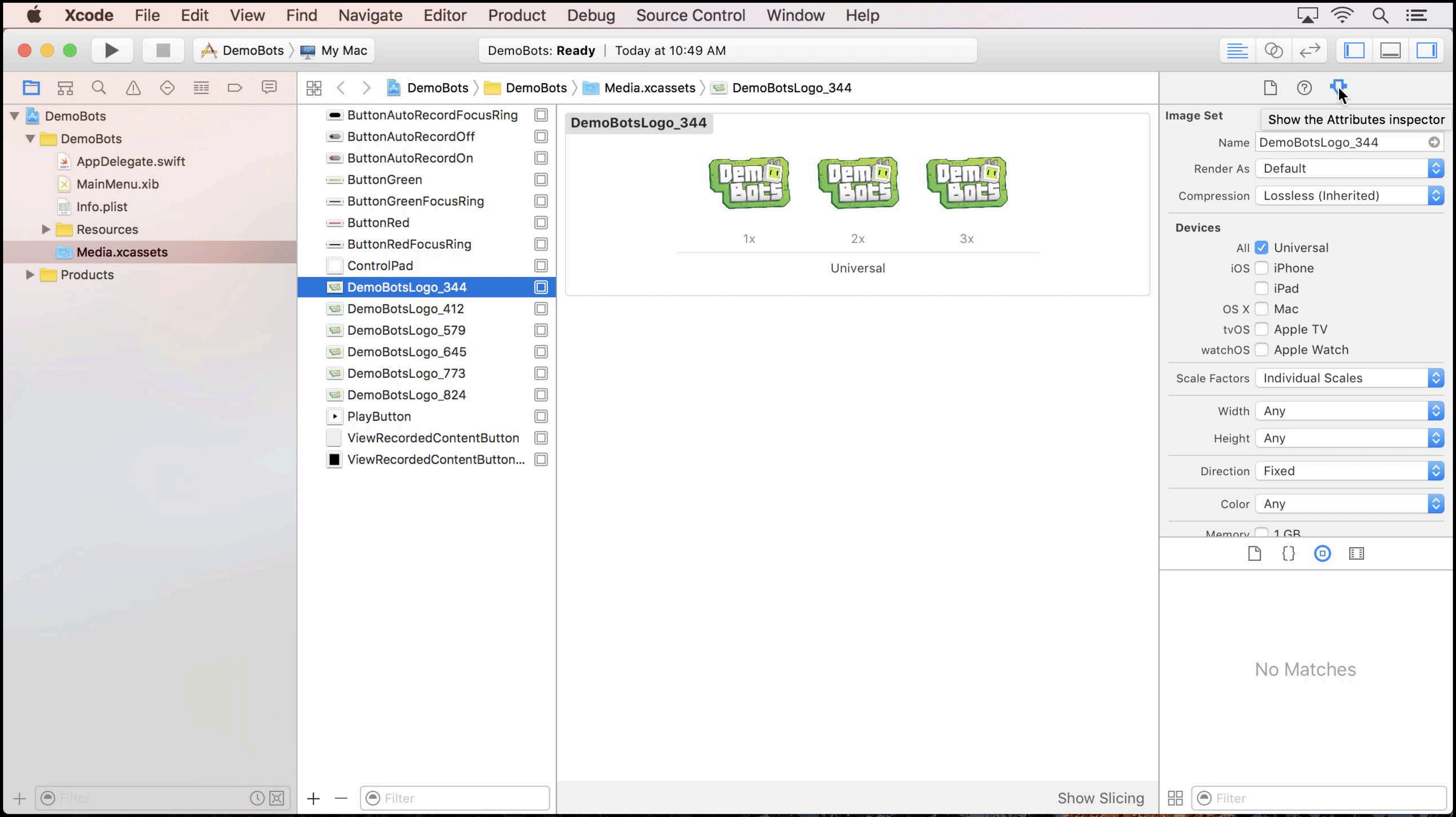
DemoBotsLogo_579
DemoBotsLogo_645
DemoBotsLogo_773
DemoBotsLogo_824
PlayButton
ViewRecordedContentButton
ViewRecordedContentButton...
No Selection
Filter


Xcode File Edit View Find Navigate Editor Product Debug Source Control Window Help
DemoBots My Mac
DemoBots: Ready | Today at 10:49 AM
DemoBots DemoBots Media.xcassets DemoBotsLogo_344
Show the Attributes inspector

DemoBots
DemoBots
AppDelegate.swift
MainMenu.xib
Info.plist
Resources
Media.xcassets
Products

ButtonAutoRecordFocusRing
ButtonAutoRecordOff
ButtonAutoRecordOn
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DemoBotsLogo_412
DemoBotsLogo_579
DemoBotsLogo_645
DemoBotsLogo_773
DemoBotsLogo_824
PlayButton
ViewRecordedContentButton
ViewRecordedContentButton...

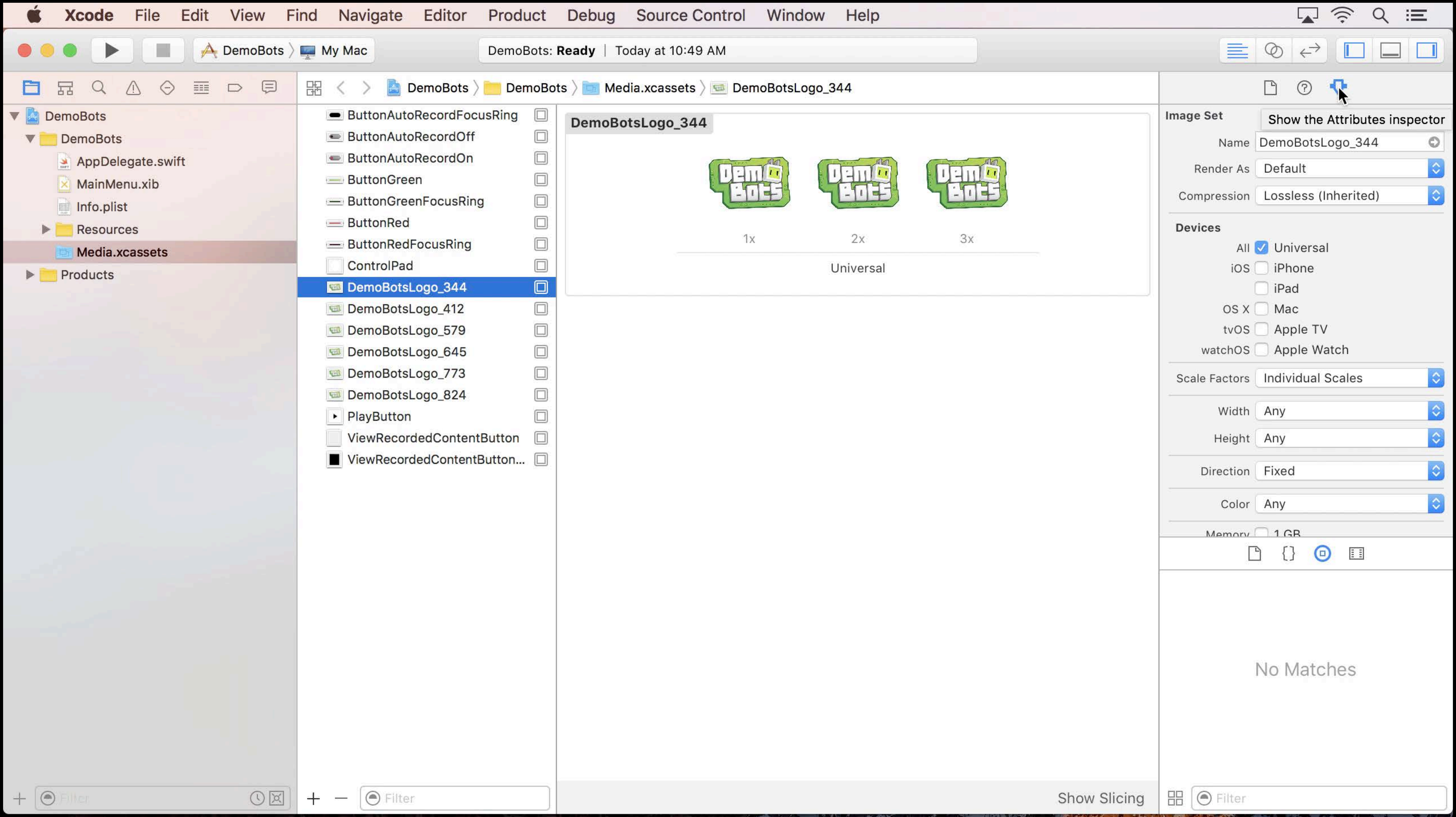
DemoBotsLogo_344
1x 2x 3x
Universal
Show Slicing

Image Set
Name DemoBotsLogo_344
Render As Default
Compression Lossless (Inherited)

Devices
All [✓ Universal]
iOS iPhone
iPad
OS X Mac
tvOS Apple TV
watchOS Apple Watch

Scale Factors Individual Scales
Width Any
Height Any
Direction Fixed
Color Any
Memory 1 GB

No Matches


Xcode File Edit View Find Navigate Editor Product Debug Source Control Window Help
DemoBots
My Mac
Show the Attributes inspector
1x
2x
3x
Universal
No Matches
Show Slicing
Filter

DemoBots: **Ready** | Today at 10:49 AM

DemoBots › DemoBots › Media.xcassets › DemoBotsLogo_344

- DemoBots
  - DemoBots
    - AppDelegate.swift
    - MainMenu.xib
    - Info.plist
    - Resources
    - Media.xcassets
  - Products

ButtonAutoRecordFocusRing
ButtonAutoRecordOff
ButtonAutoRecordOn
ButtonGreen
ButtonGreenFocusRing
ButtonRed
ButtonRedFocusRing
ControlPad
DemoBotsLogo_344
DemoBotsLogo_412
DemoBotsLogo_579
DemoBotsLogo_645
DemoBotsLogo_773
DemoBotsLogo_824
PlayButton
ViewRecordedContentButton
ViewRecordedContentButton...

DemoBotsLogo_344

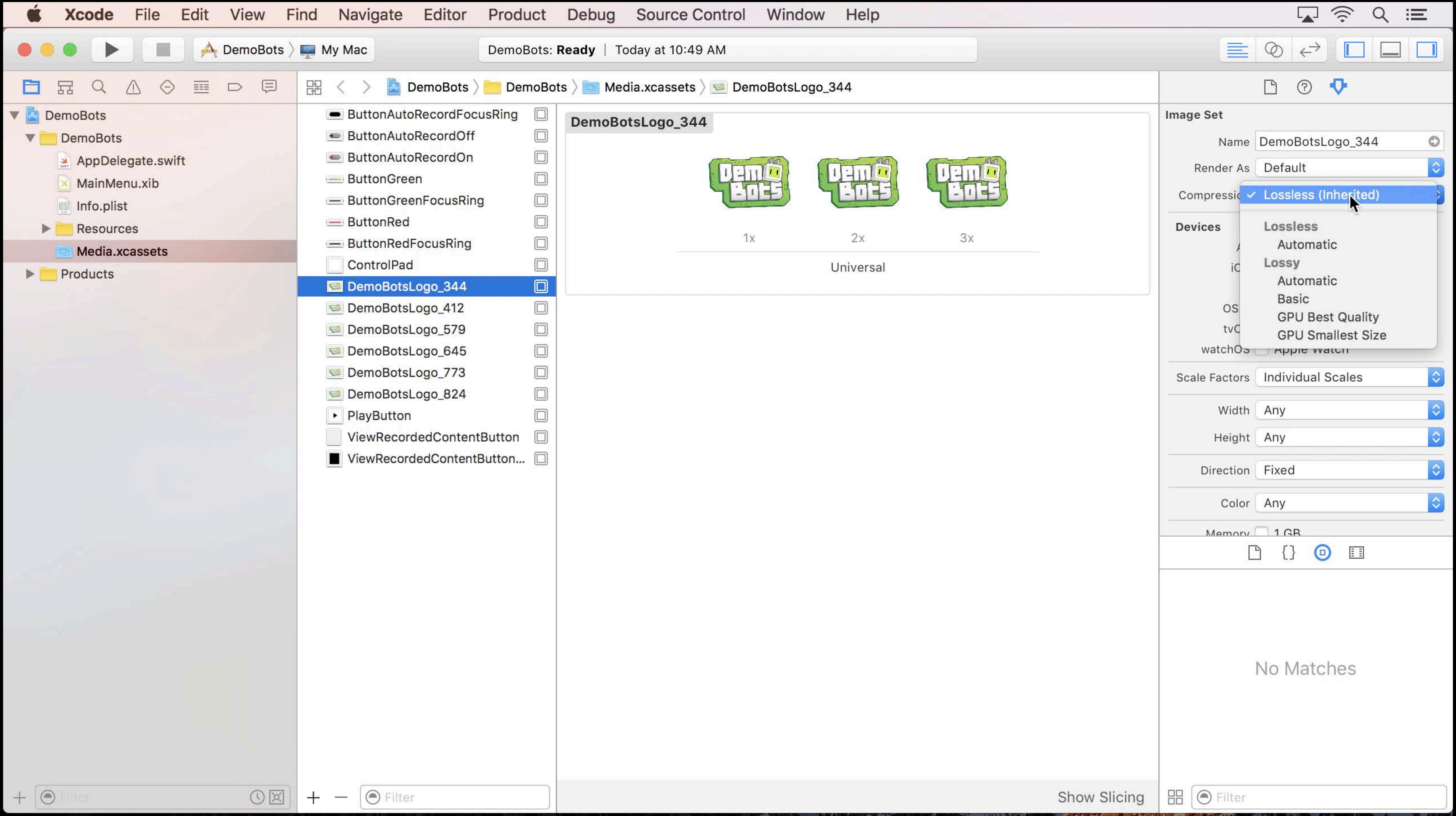
Image Set

Name	DemoBotsLogo_344
Render As	Default
Compression	Lossless (Inherited)

Devices

All	[✓ Universal]
iOS	iPhone
	iPad
OS X	Mac
tvOS	Apple TV
watchOS	Apple Watch

Scale Factors	Individual Scales
Width	Any
Height	Any
Direction	Fixed
Color	Any
Memory	1 GB


Xcode
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Edit
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Find
Navigate
Editor
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Source Control
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DemoBots: Ready | Today at 10:49 AM
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DemoBotsLogo_579
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DemoBotsLogo_773
DemoBotsLogo_824
PlayButton
ViewRecordedContentButton
ViewRecordedContentButton...
DemoBotsLogo_344
1x
2x
3x
Universal
Show Slicing
Image Set
Name DemoBotsLogo_344
Render As Default
Compression
✓ Lossless (Inherited)
Lossless
Automatic
Lossy
Automatic
Basic
GPU Best Quality
GPU Smallest Size
Devices
watchOS Apple Watch
Scale Factors Individual Scales
Width Any
Height Any
Direction Fixed
Color Any
Memory 1 GB
No Matches
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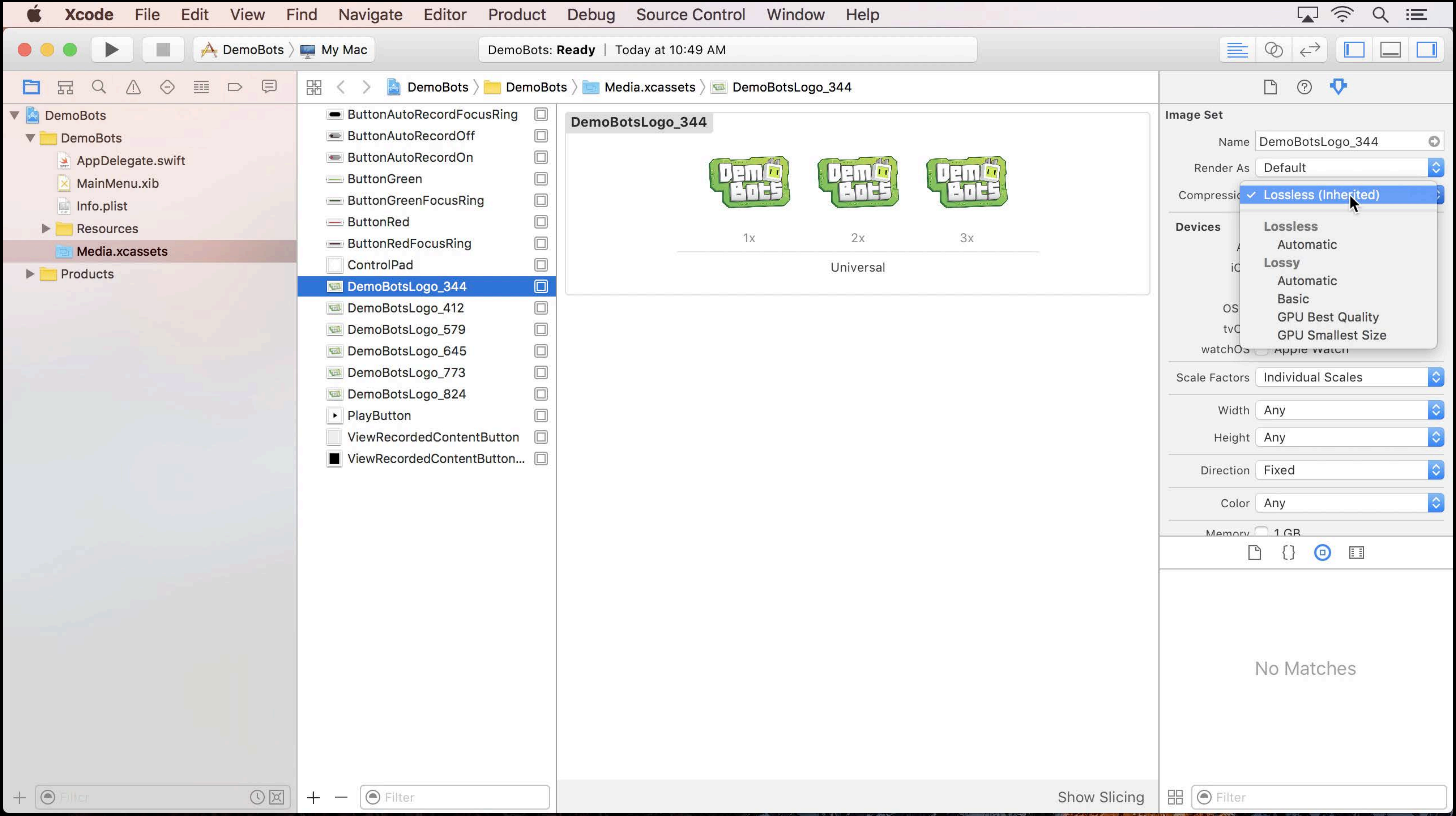
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DemoBots
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1x
2x
3x
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Show Slicing
Image Set
Name DemoBotsLogo_344
Render As Default
Compression
✓ Lossless (Inherited)
Lossless
Automatic
Lossy
Automatic
Basic
GPU Best Quality
GPU Smallest Size
Devices
watchOS Apple Watch
Scale Factors Individual Scales
Width Any
Height Any
Direction Fixed
Color Any
Memory 1 GB
No Matches
Filter

Storing Your Data

Serialized Data Formats

Serialized Data Formats

Plists, XML, JSON, etc.

Serialized Data Formats

Plists, XML, JSON, etc.

- Common and easy to use

Serialized Data Formats

Plists, XML, JSON, etc.

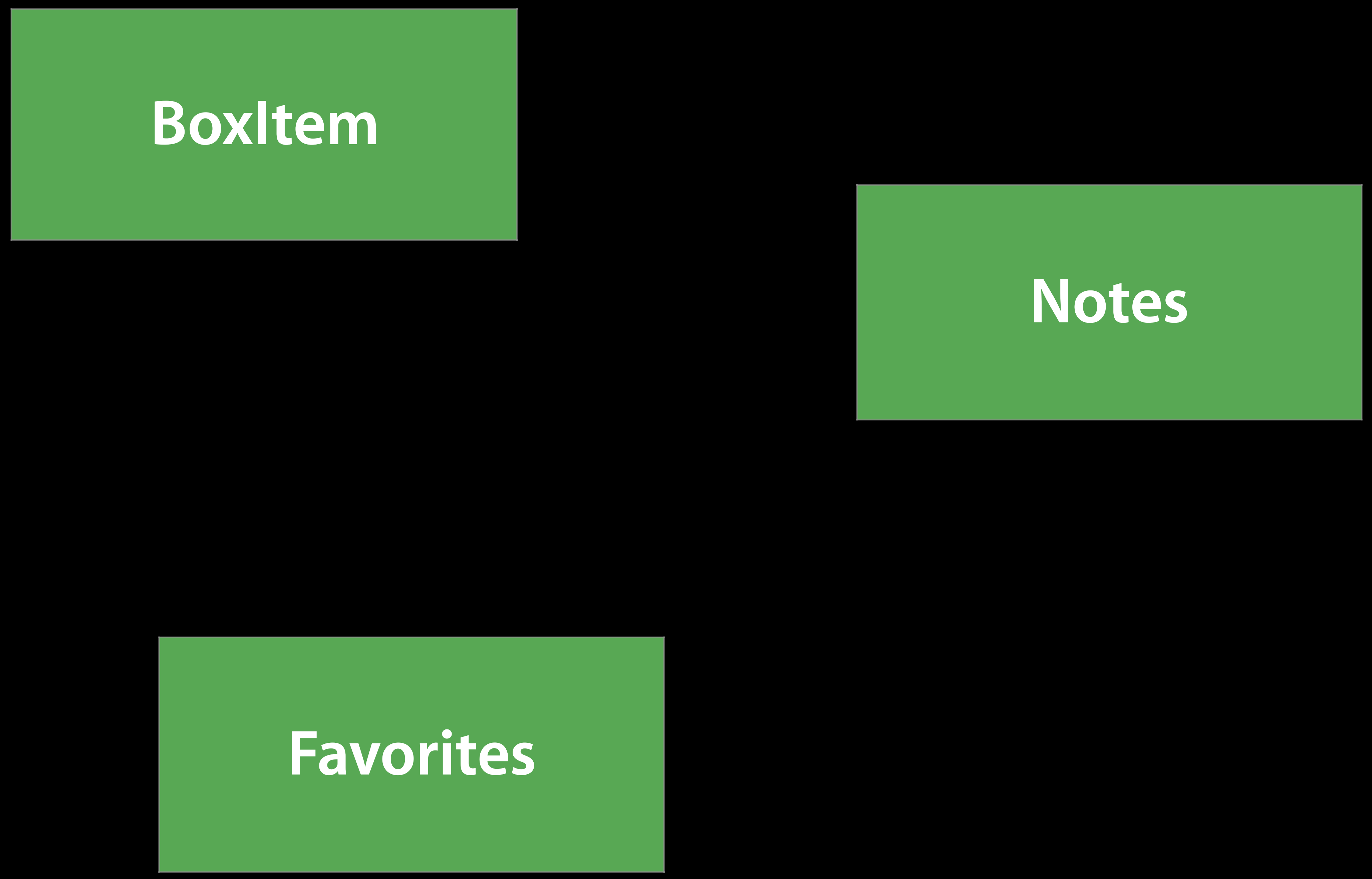
- Common and easy to use
- Good for read-only data

Serialized Data Formats

Plists, XML, JSON, etc.

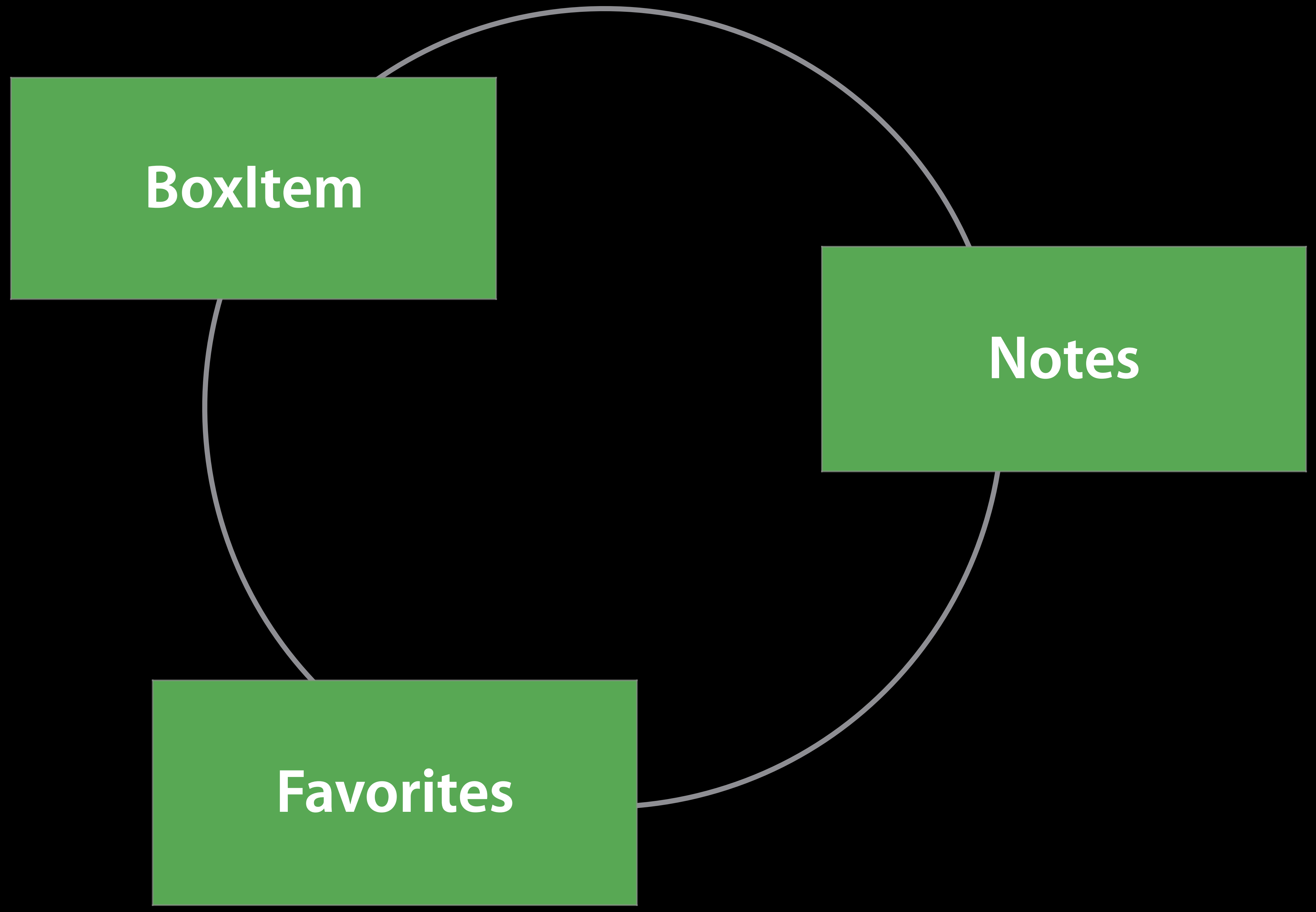
- Common and easy to use
- Good for read-only data
- Not a database

Core Data



Core Data

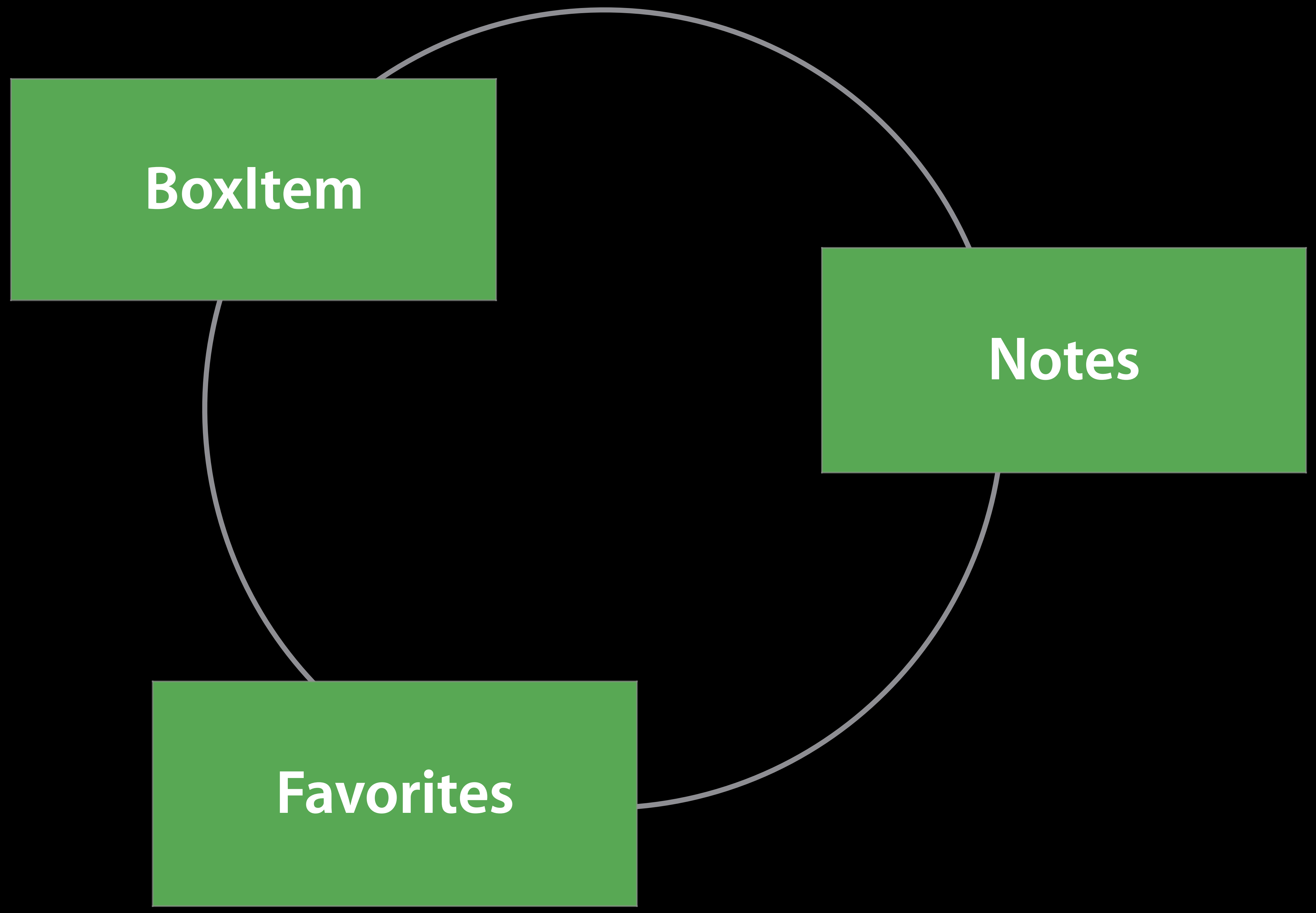
Cocoa data management



Core Data

Cocoa data management

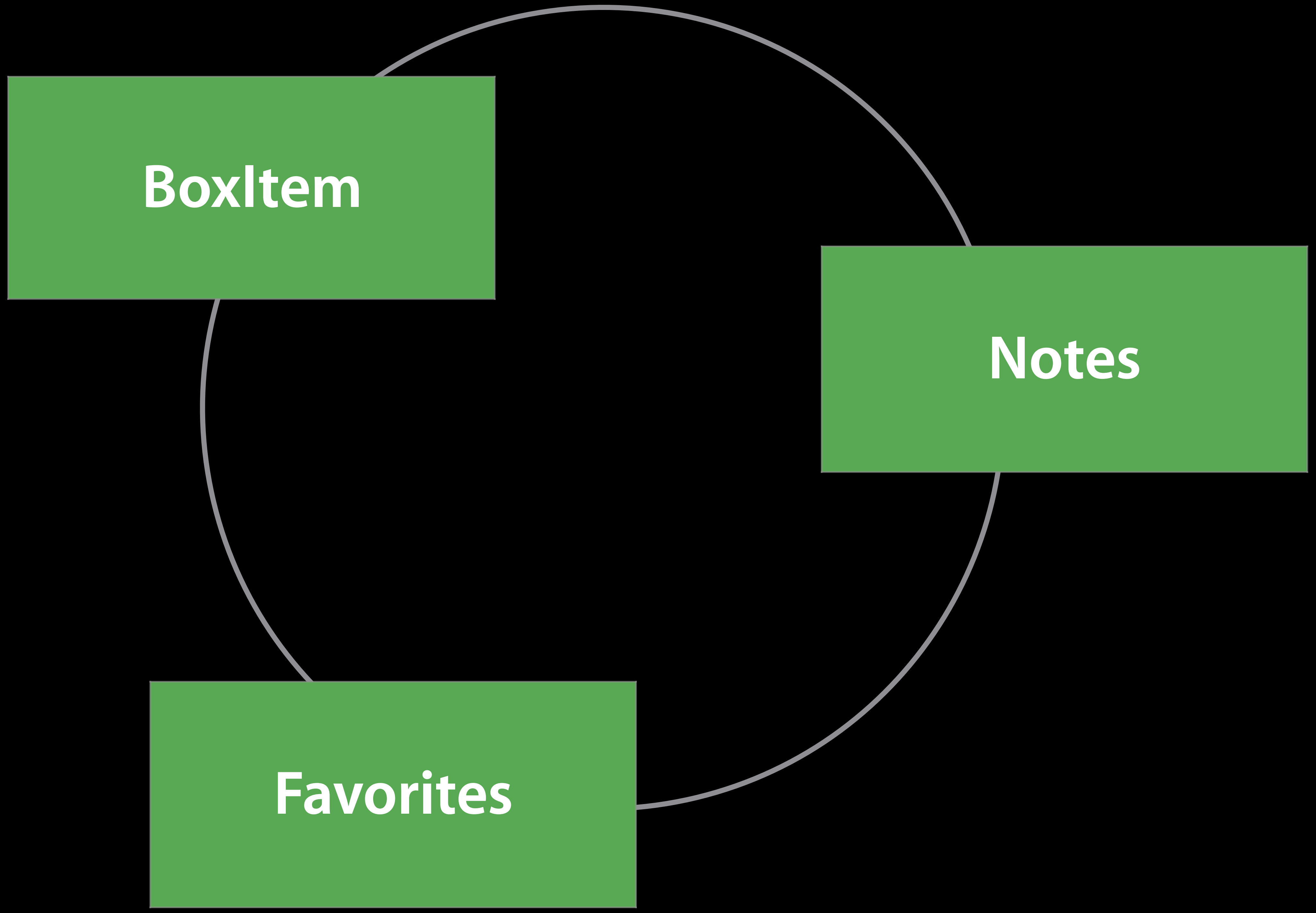
- Data persistence



Core Data

Cocoa data management

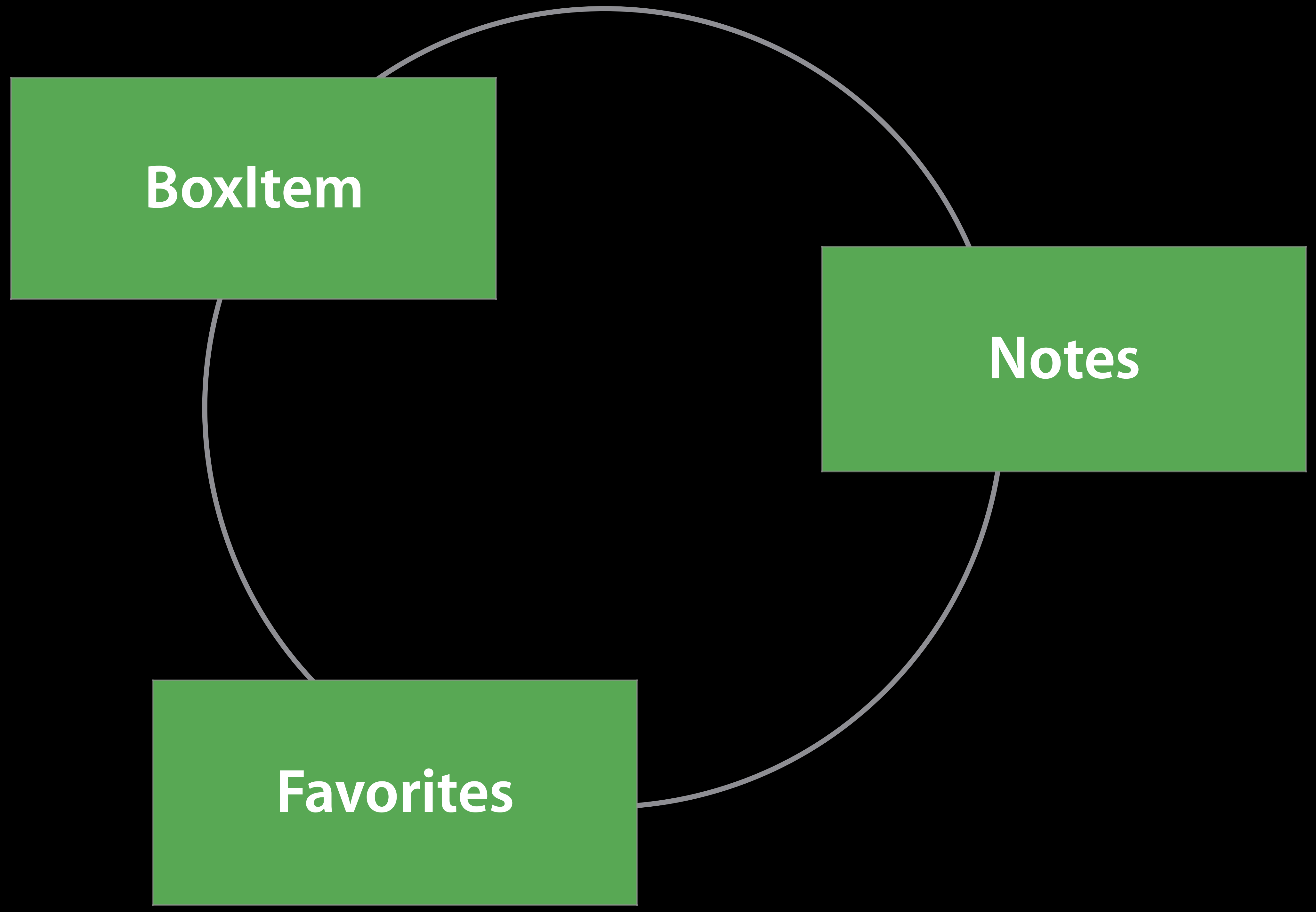
- Data persistence
- Object graphs and relationships



Core Data

Cocoa data management

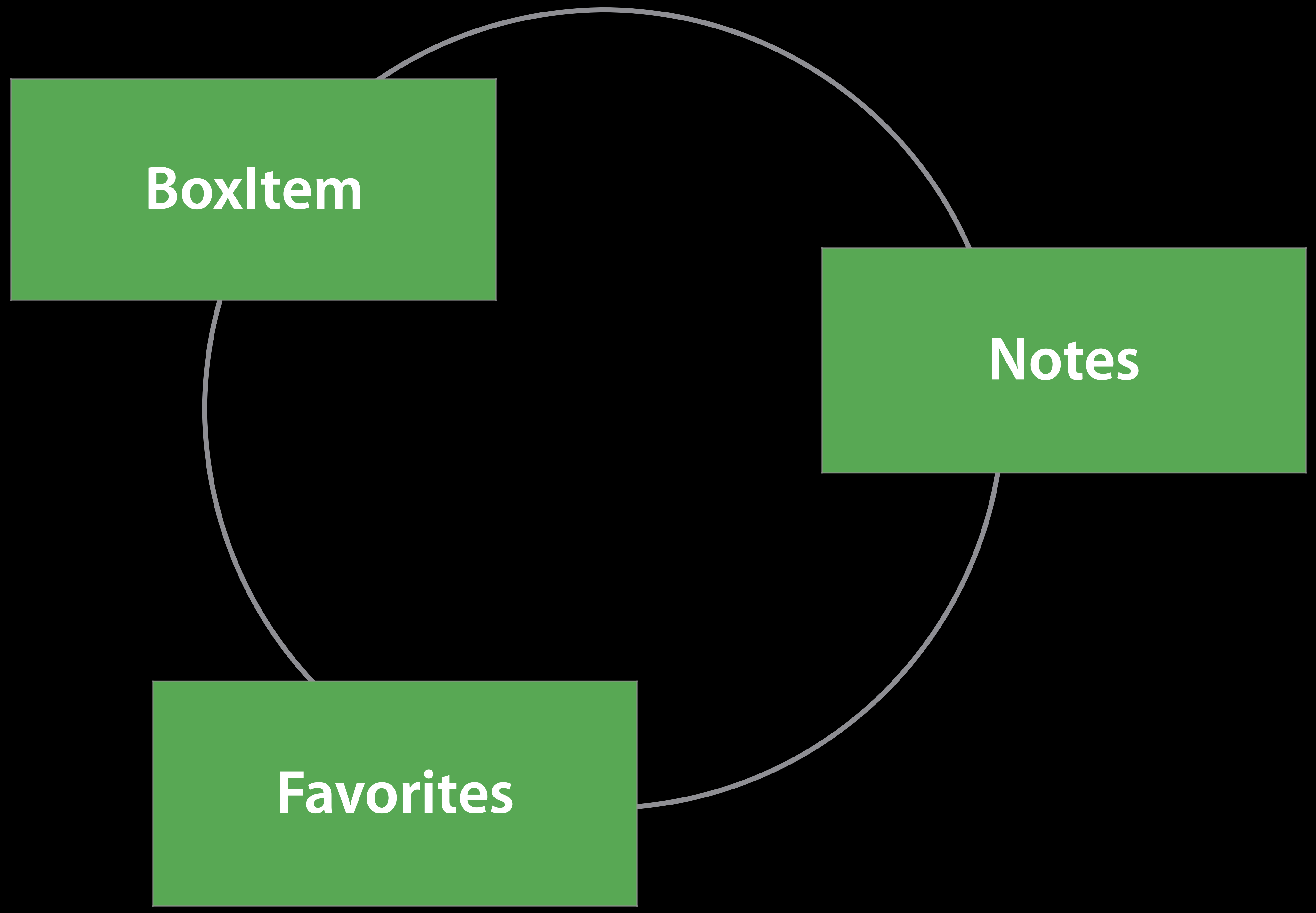
- Data persistence
- Object graphs and relationships
- Change tracking



Core Data

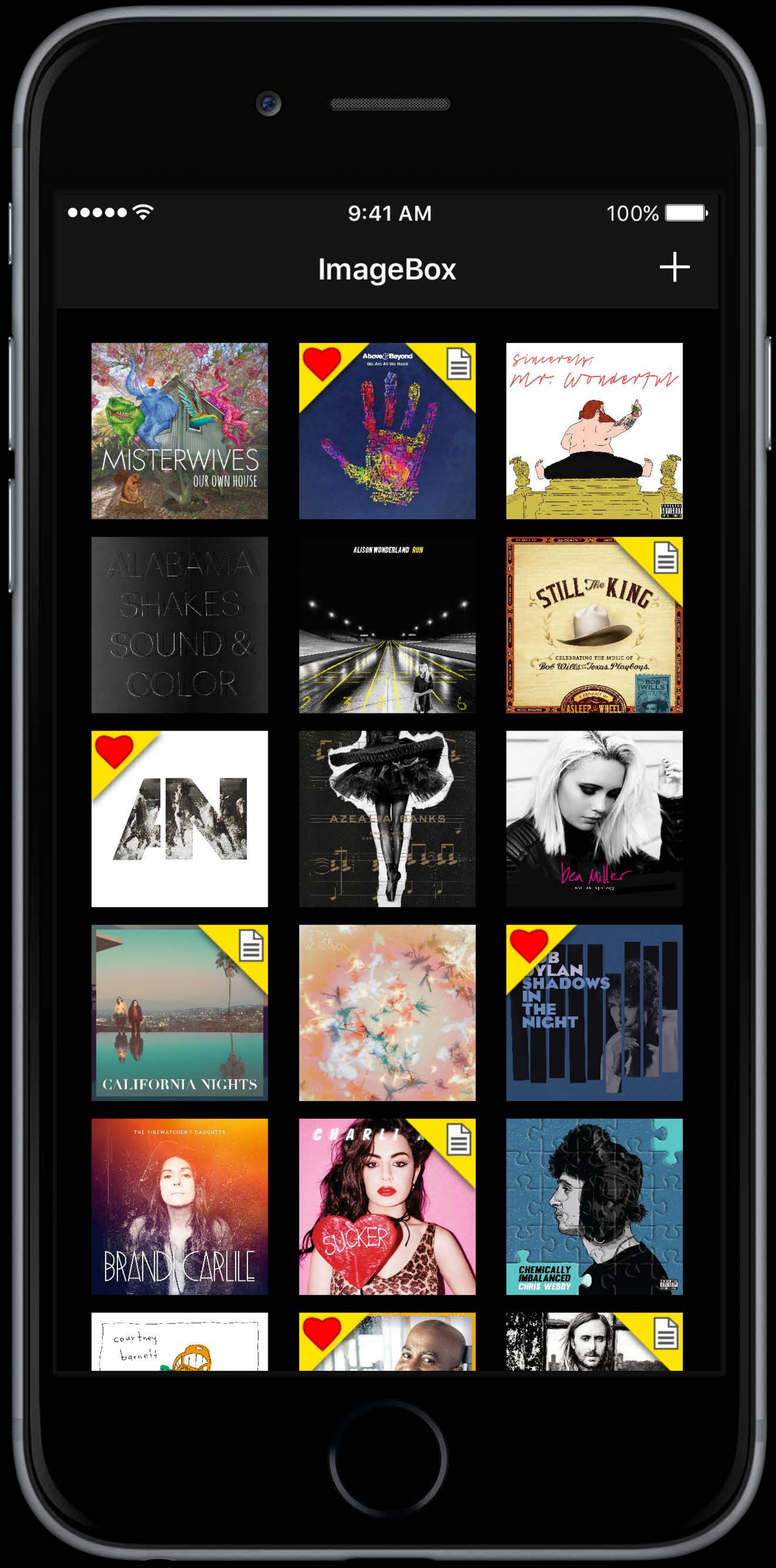
Cocoa data management

- Data persistence
- Object graphs and relationships
- Change tracking
- Xcode toolchain support



Designing Your Model

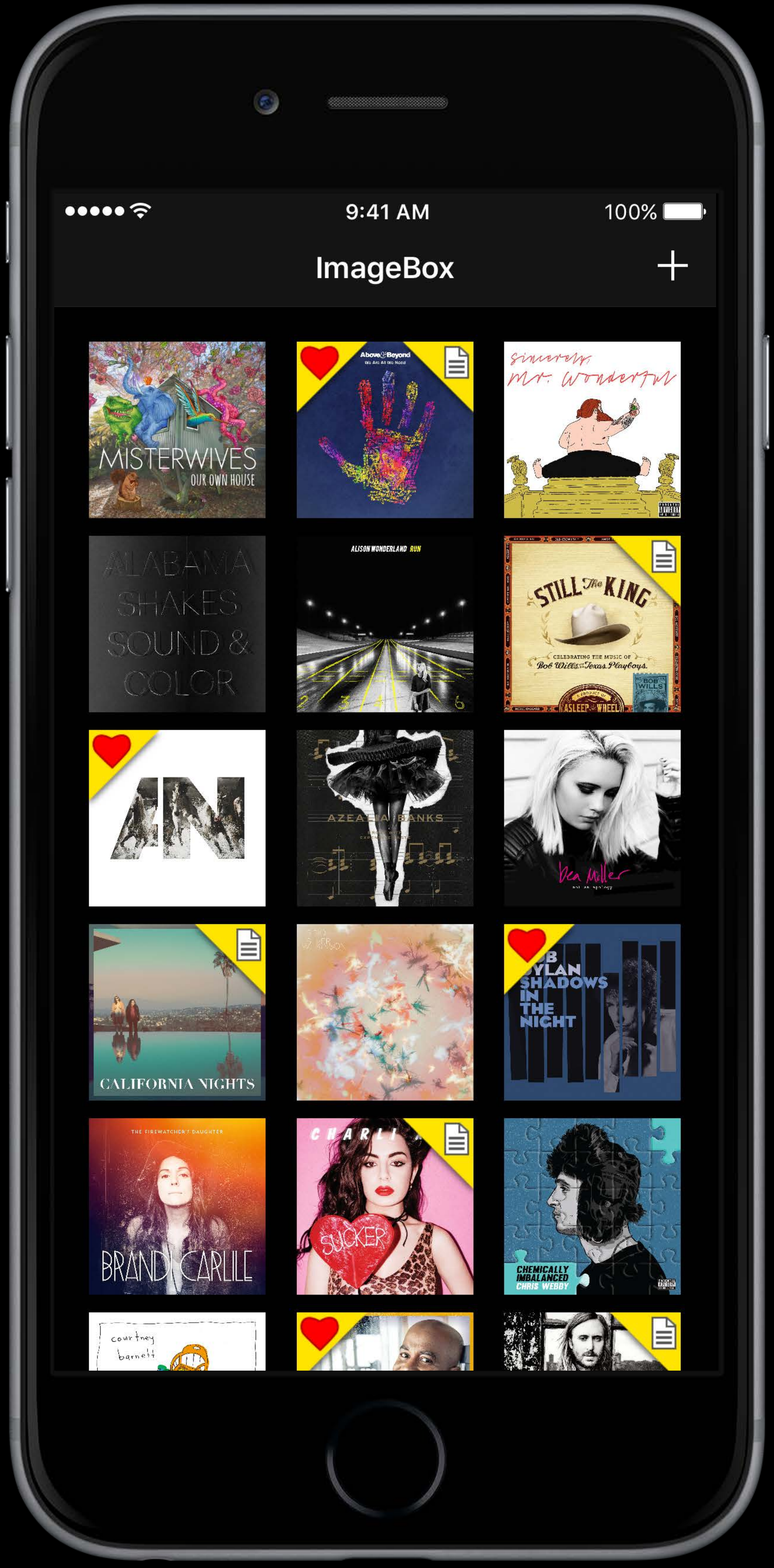
Designing Your Model



Designing Your Model

BoxItem

favorite	Boolean
imageData	Data
notes	Relationship



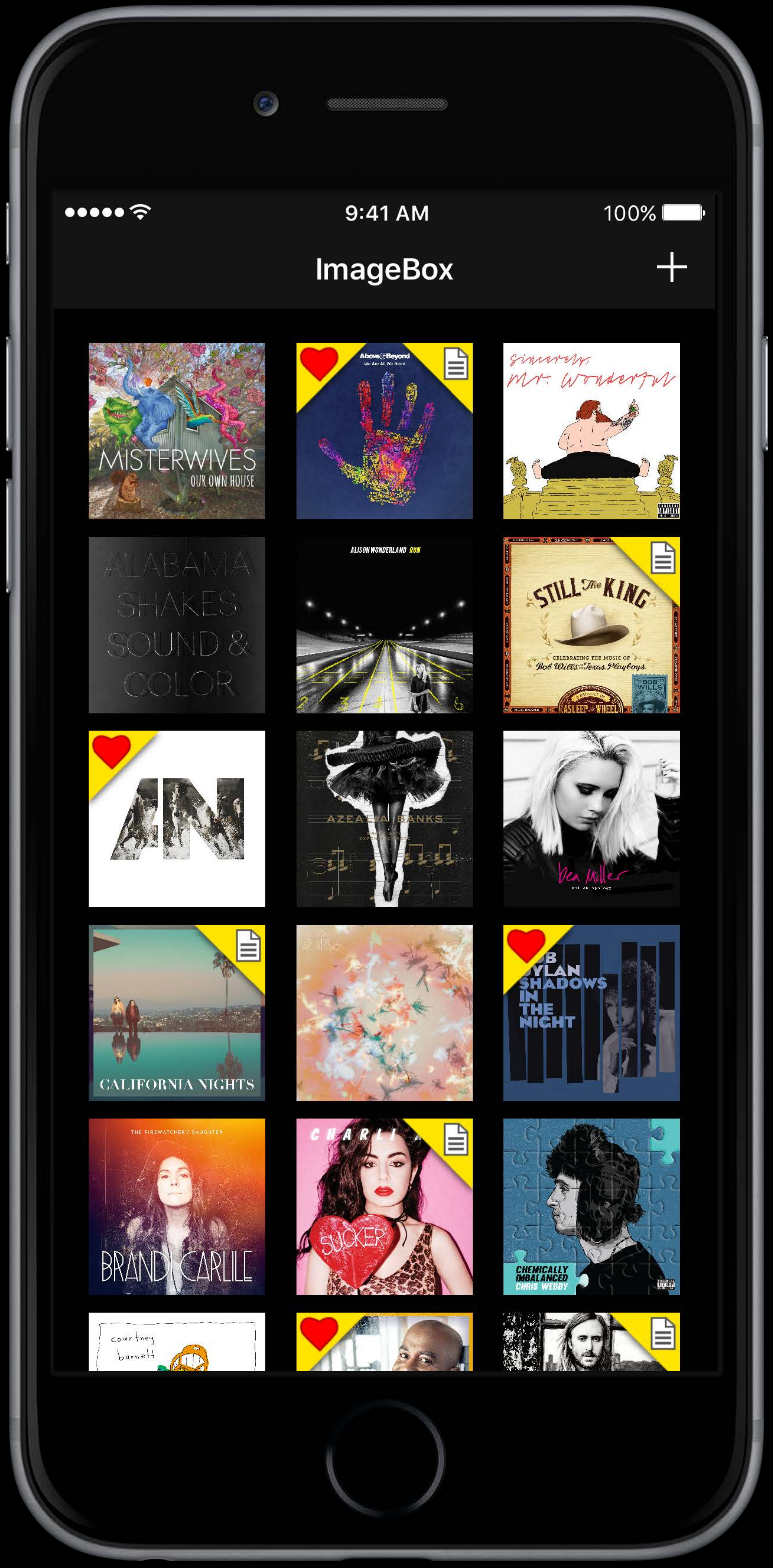
Designing Your Model

BoxItem

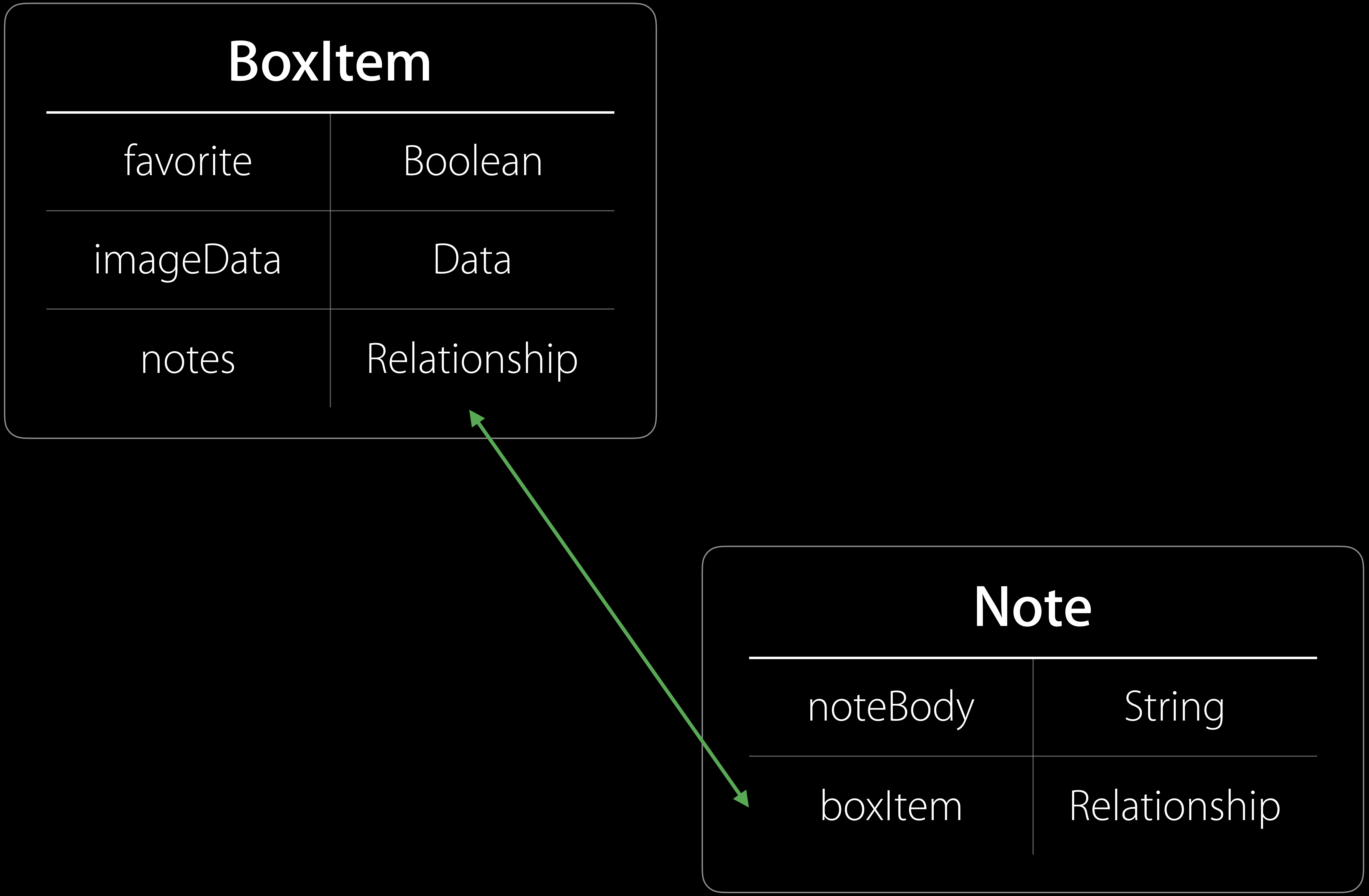
favorite	Boolean
imageData	Data
notes	Relationship

Note

noteBody	String
boxItem	Relationship

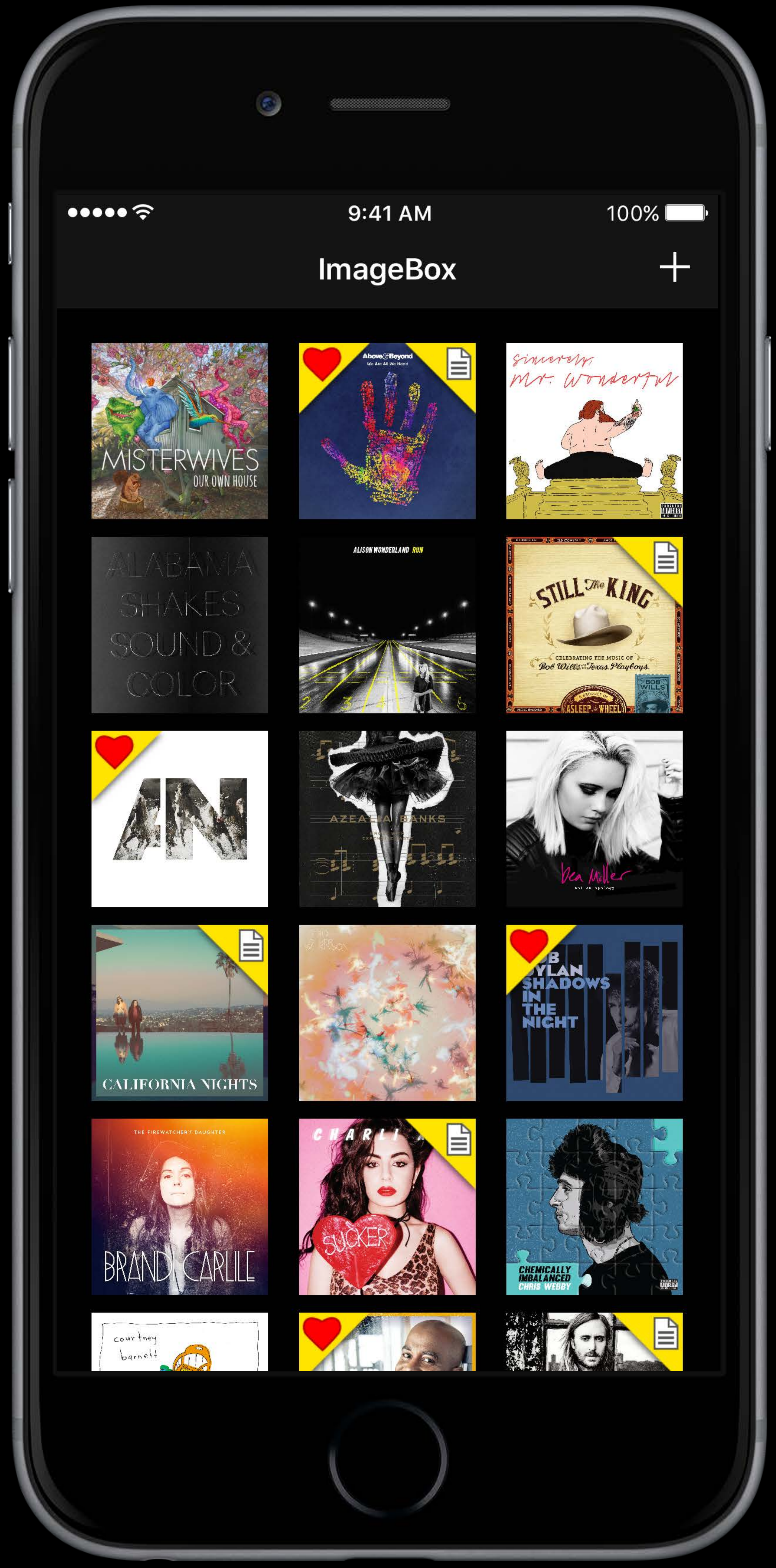


Designing Your Model



BoxItem	
favorite	Boolean
imageData	Data
notes	Relationship

Note	
noteBody	String
boxItem	Relationship



Core Data Performance

Measure, measure, measure

Core Data Performance

Measure, measure, measure

```
-com.apple.CoreData.SQLDebug <1-3>
```

Core Data Performance

Measure, measure, measure

```
-com.apple.CoreData.SQLDebug <1-3>
```

Instruments Core Data template

Core Data Performance

Measure, measure, measure

```
-com.apple.CoreData.SQLDebug <1-3>
```

Instruments Core Data template

SQLite query analysis tools

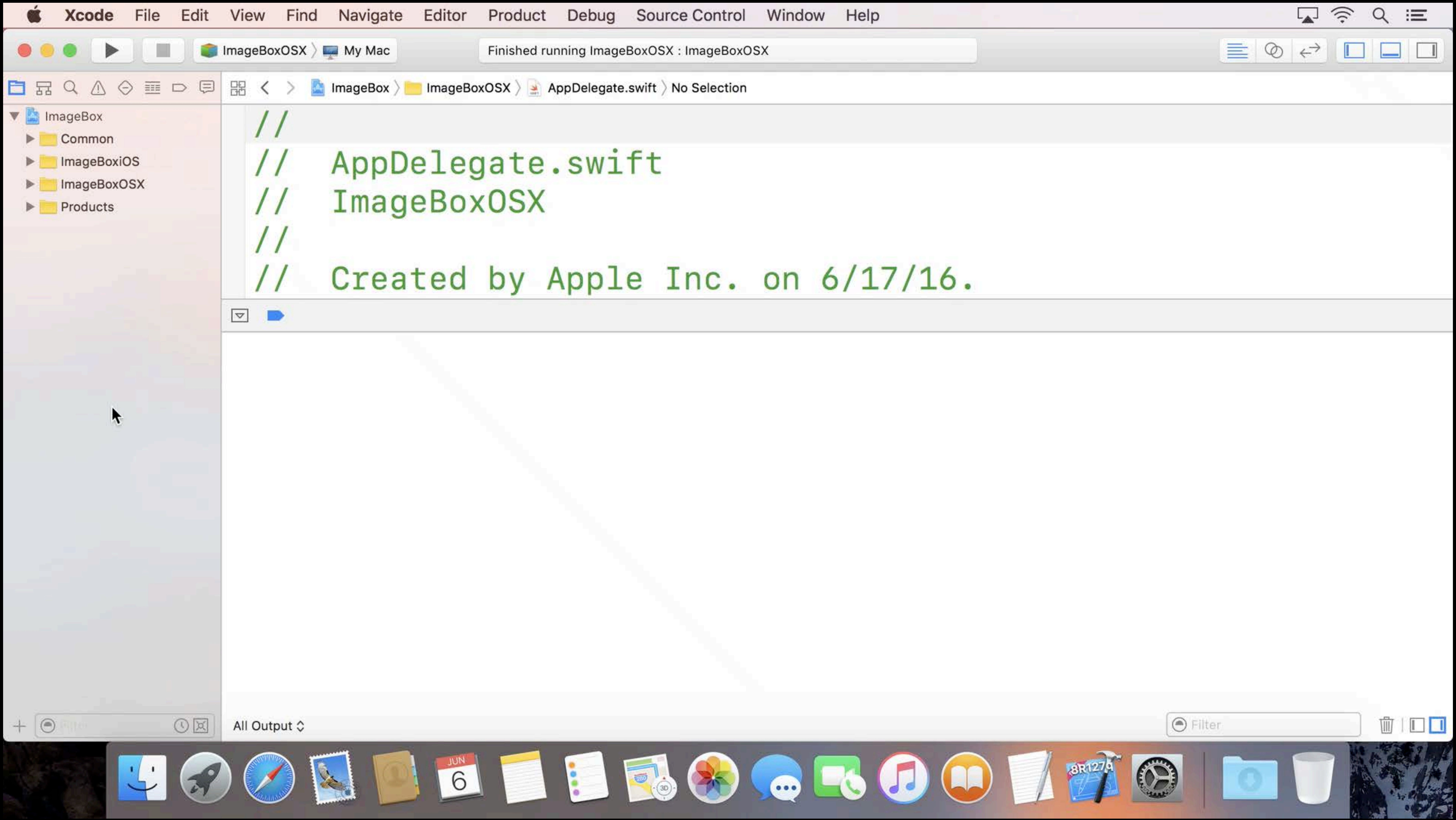
Core Data Performance

Measure, measure, measure

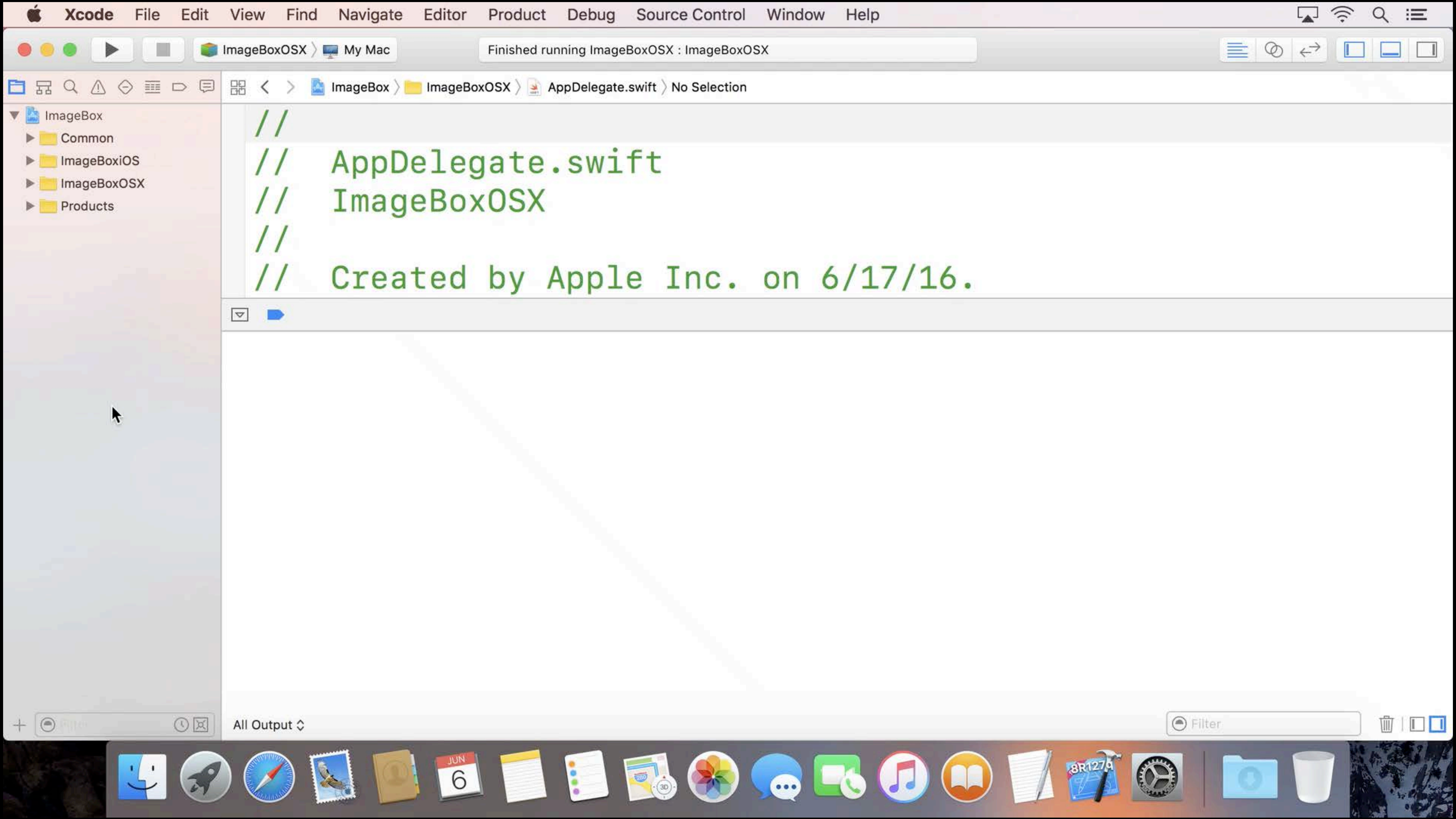
```
-com.apple.CoreData.SQLDebug <1-3>
```

Instruments Core Data template

SQLite query analysis tools



```
//
//  AppDelegate.swift
//  ImageBoxOSX
//
//  Created by Apple Inc. on 6/17/16.
```



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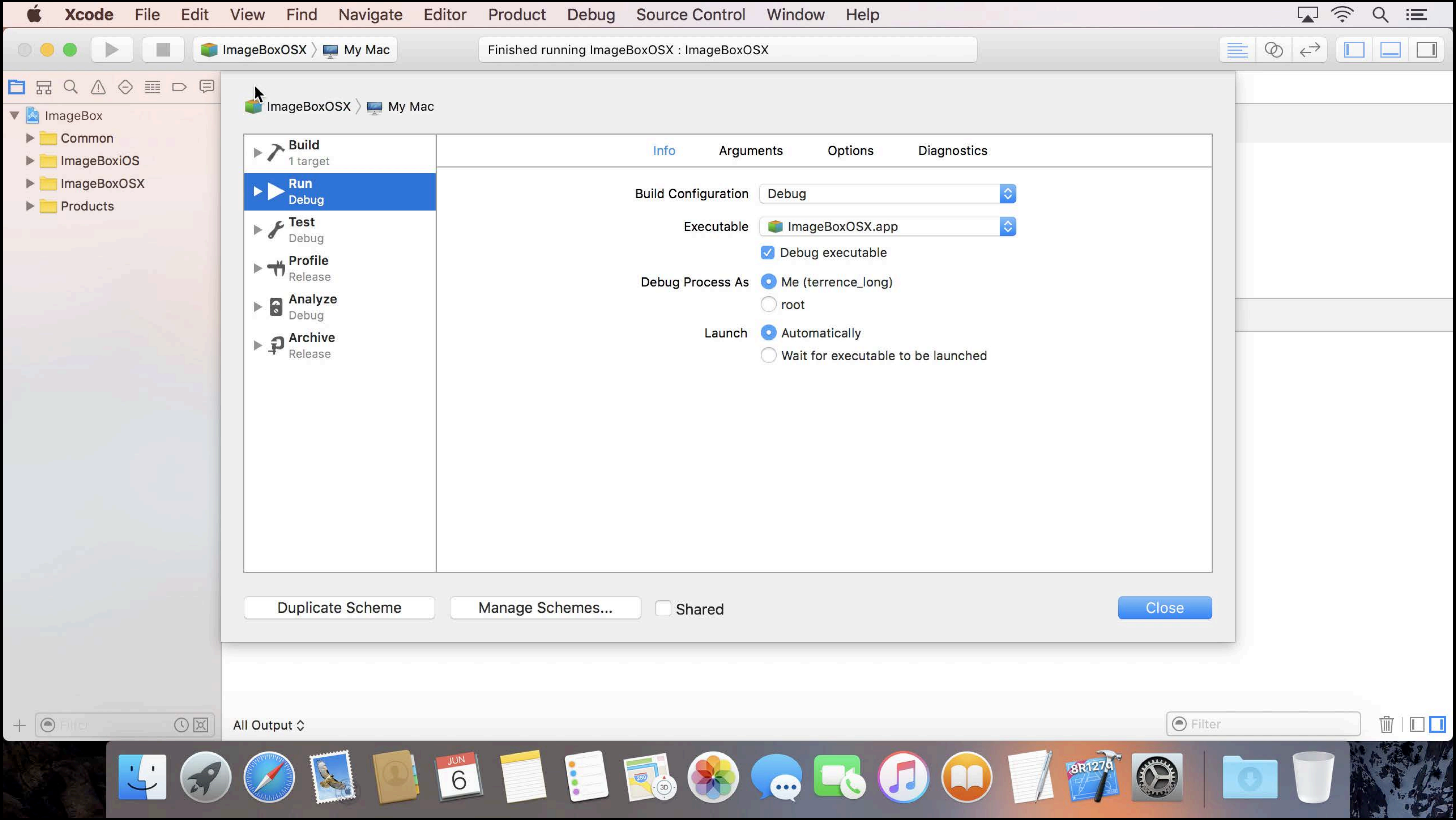
//
//  AppDelegate.swift
//  ImageBoxOSX
//
//  Created by Apple Inc. on 6/17/16.
```



Finished running ImageBoxOSX : ImageBoxOSX

ImageBoxOSX 〉 My Mac

- Build — 1 target
- Run — Debug
- Test — Debug
- Profile — Release
- Analyze — Debug
- Archive — Release

Info | Arguments | Options | Diagnostics

Build Configuration: Debug

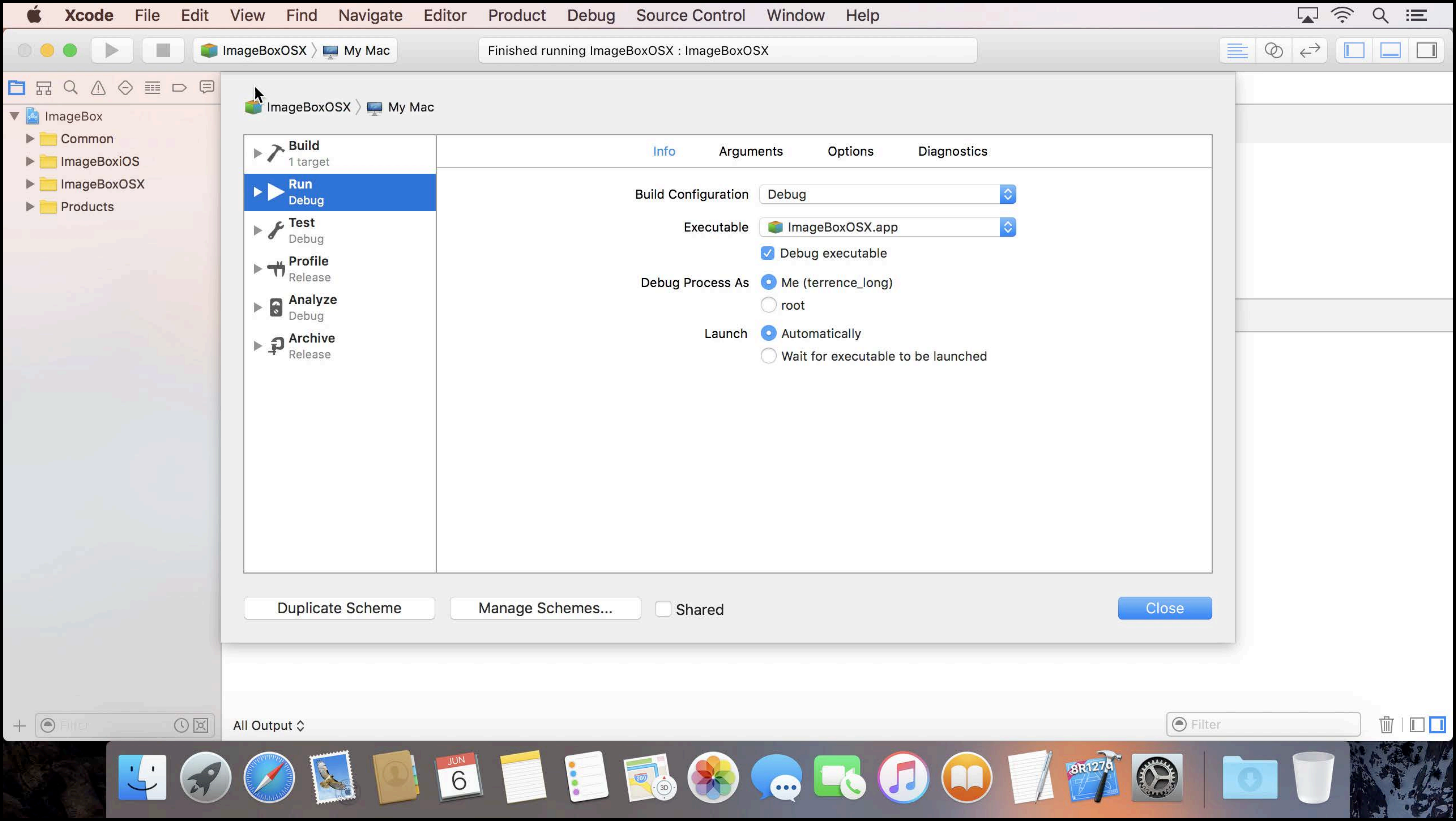
Executable: ImageBoxOSX.app

[✓] Debug executable

Debug Process As: [✓ Me (terrence_long)] root

Launch: [✓ Automatically] Wait for executable to be launched

Duplicate Scheme | Manage Schemes... | ☐ Shared | Close


Xcode File Edit View Find Navigate Editor Product Debug Source Control Window Help
ImageBoxOSX 〉 My Mac
ImageBox
Common
ImageBoxiOS
ImageBoxOSX
Products
All Output

Finished running ImageBoxOSX : ImageBoxOSX

ImageBoxOSX 〉 My Mac

Build
1 target

Run
Debug

Test
Debug

Profile
Release

Analyze
Debug

Archive
Release

Info | Arguments | Options | Diagnostics

Build Configuration: Debug

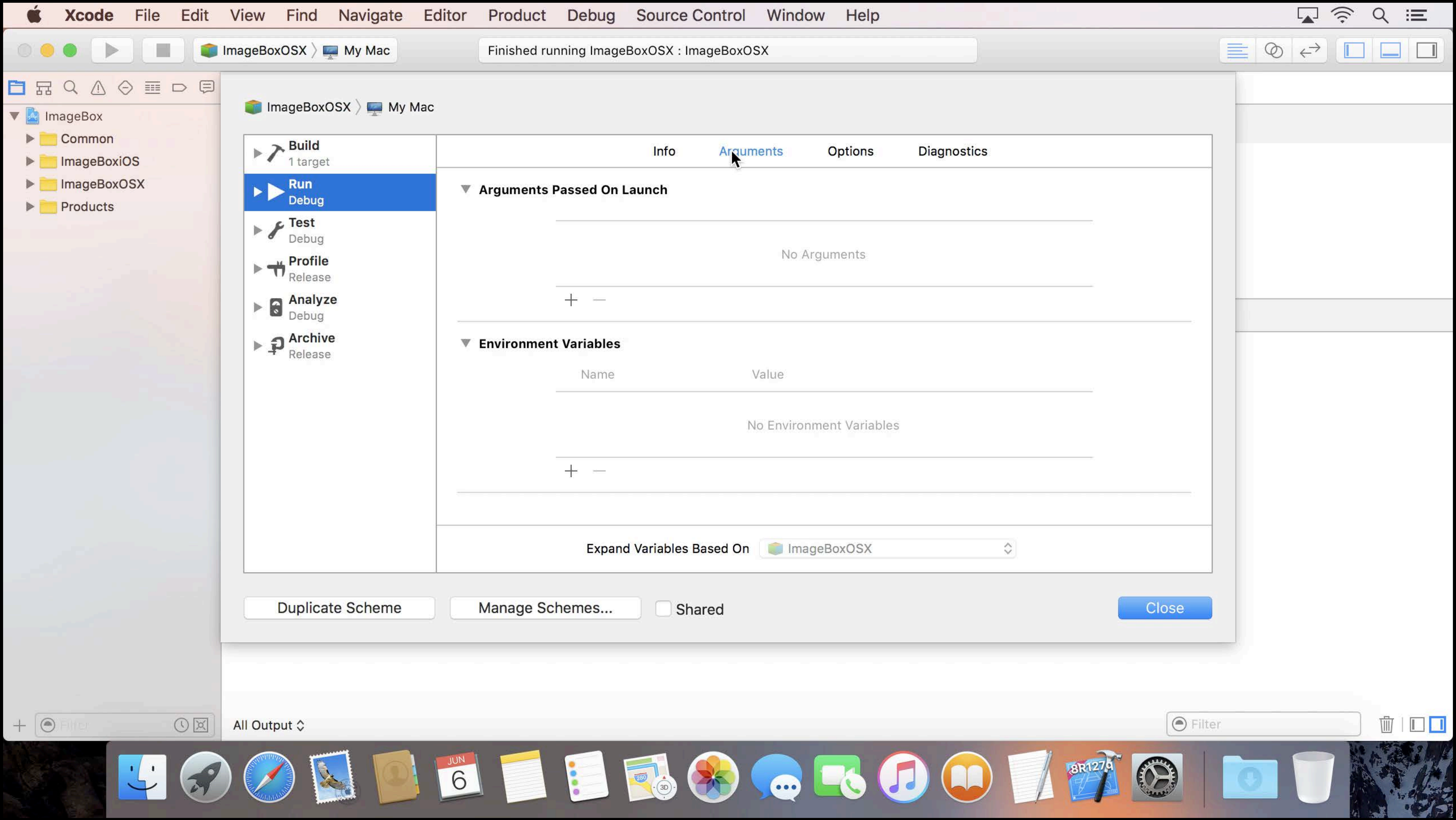
Executable: ImageBoxOSX.app

☑ Debug executable

Debug Process As: ● Me (terrence_long) ○ root

Launch: ● Automatically ○ Wait for executable to be launched

Duplicate Scheme | Manage Schemes... | ☐ Shared | Close


Xcode File Edit View Find Navigate Editor Product Debug Source Control Window Help
ImageBoxOSX 〉 My Mac
ImageBox
Common
ImageBoxiOS
ImageBoxOSX
Products
All Output
Filter

Finished running ImageBoxOSX : ImageBoxOSX

ImageBoxOSX 〉 My Mac

Build
1 target
Run
Debug
Test
Debug
Profile
Release
Analyze
Debug
Archive
Release

Info Arguments Options Diagnostics

Arguments Passed On Launch

No Arguments

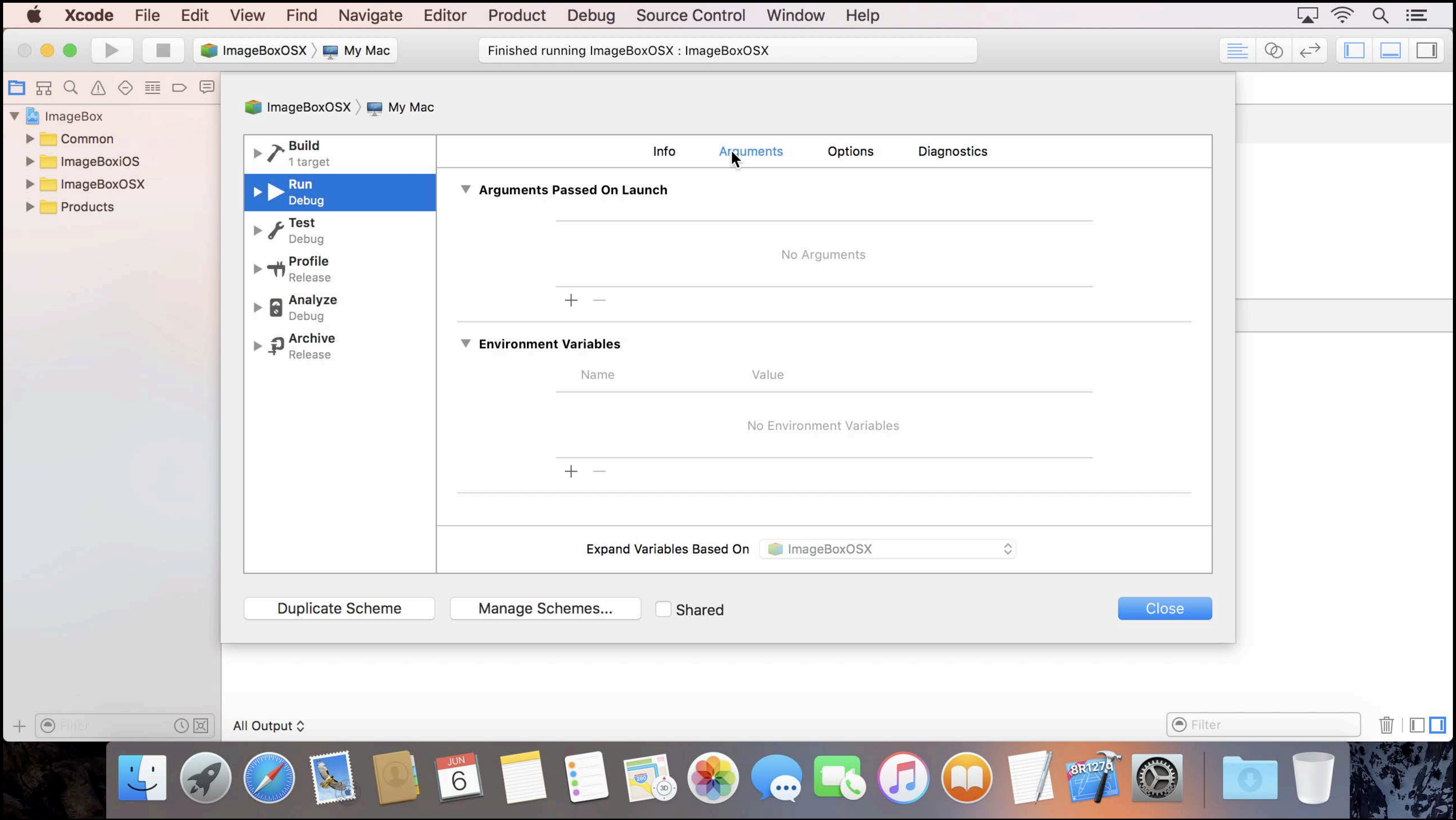
Environment Variables

Name	Value

No Environment Variables

Expand Variables Based On ImageBoxOSX

Duplicate Scheme | Manage Schemes... | ☐ Shared | Close



Finished running ImageBoxOSX : ImageBoxOSX

ImageBoxOSX 〉 My Mac

Arguments Passed On Launch

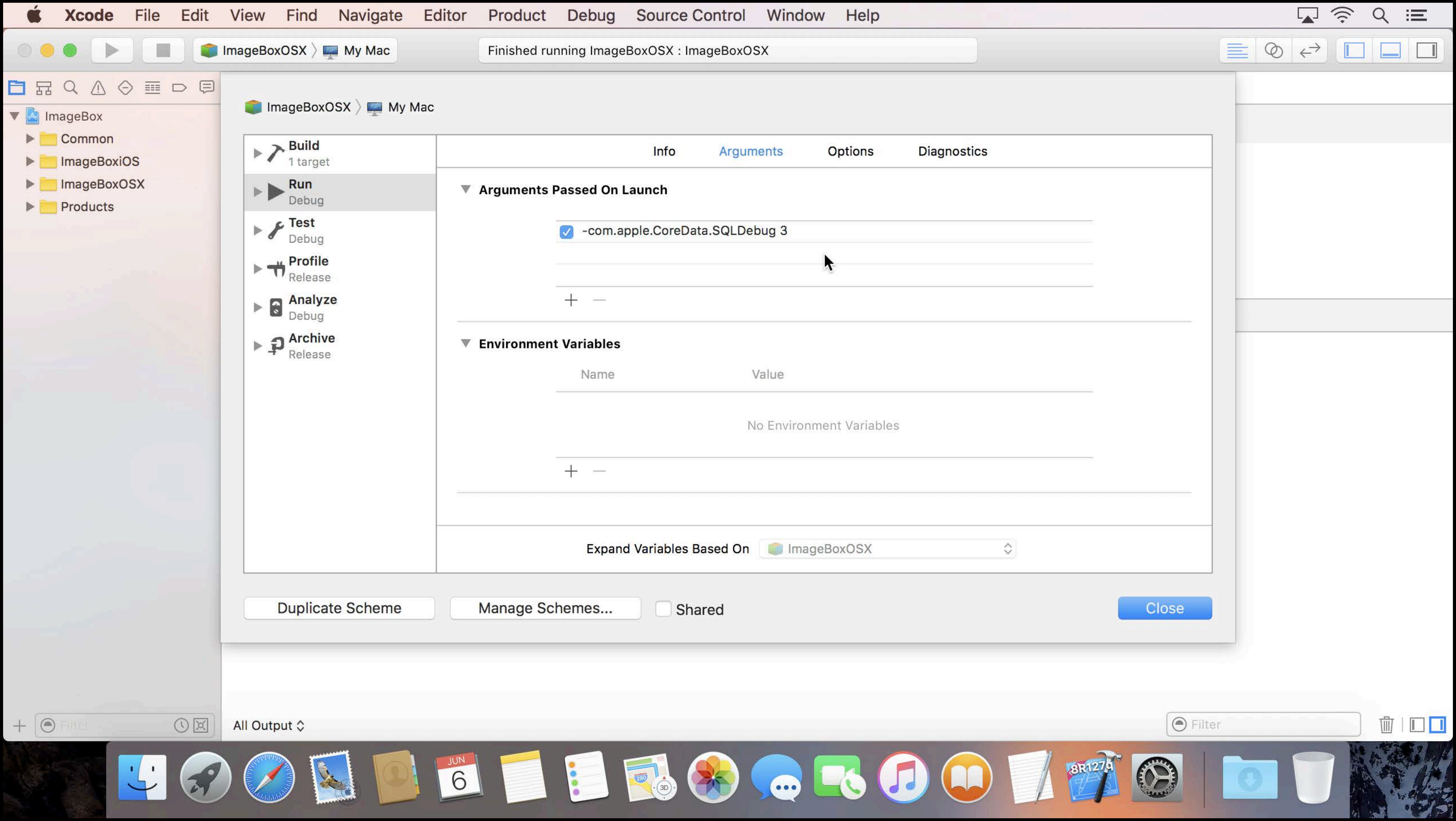
No Arguments

Environment Variables

Name	Value

No Environment Variables

Expand Variables Based On: ImageBoxOSX



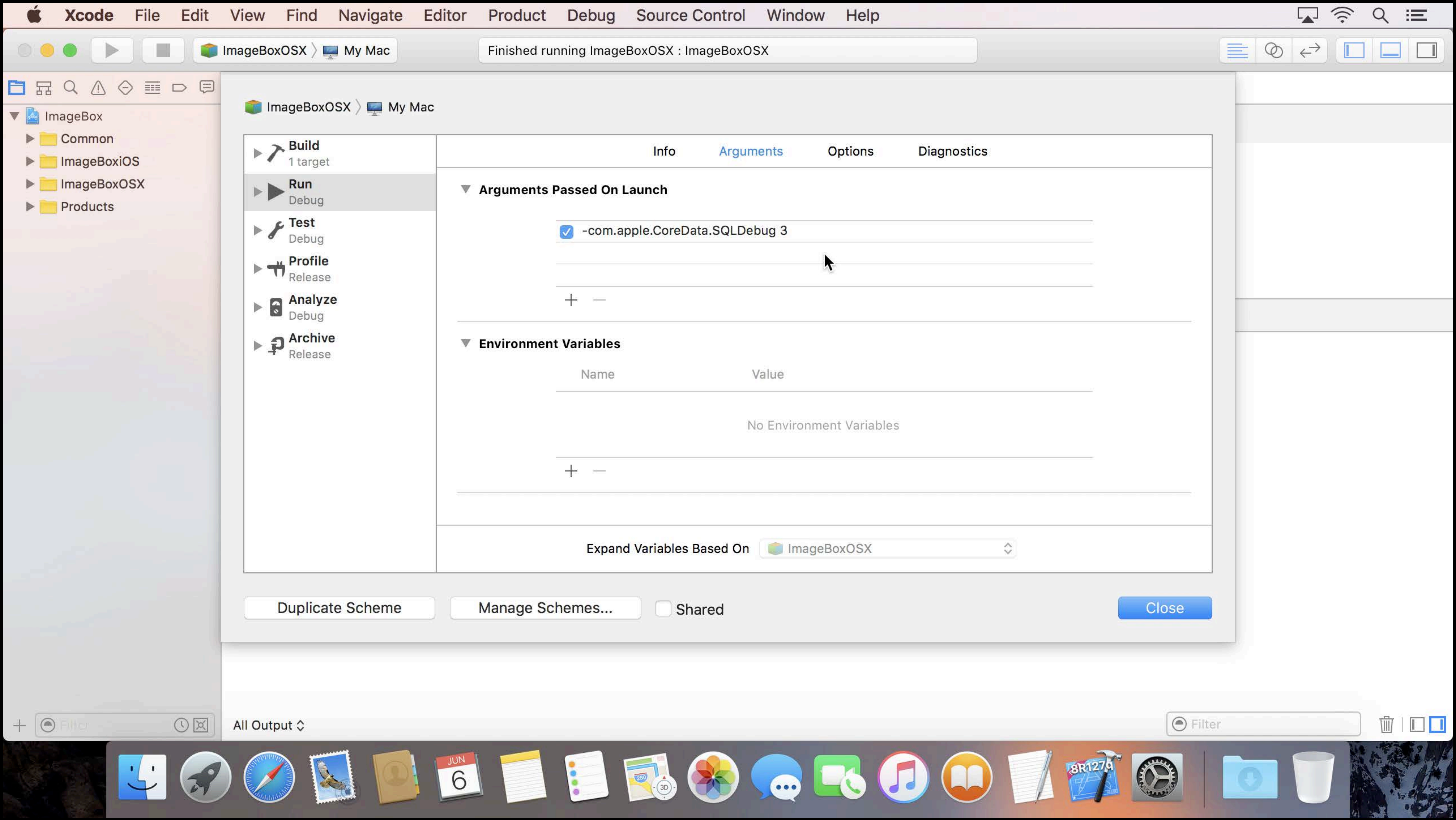
Arguments Passed On Launch

☑ -com.apple.CoreData.SQLDebug 3

Environment Variables

Name	Value
No Environment Variables	

Expand Variables Based On: ImageBoxOSX



ImageBoxOSX 〉 My Mac

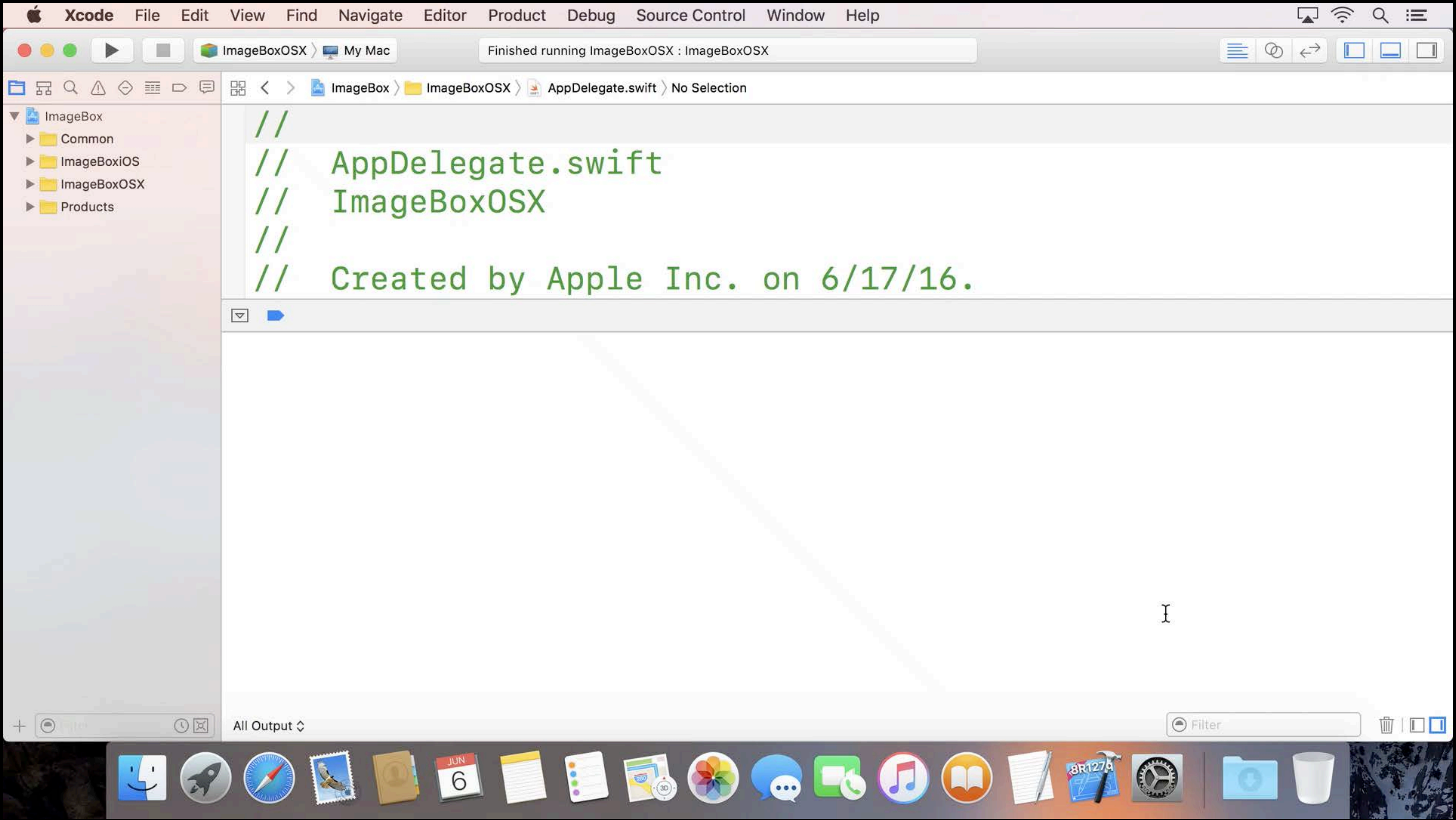
Arguments Passed On Launch

[✓] -com.apple.CoreData.SQLDebug 3

Environment Variables

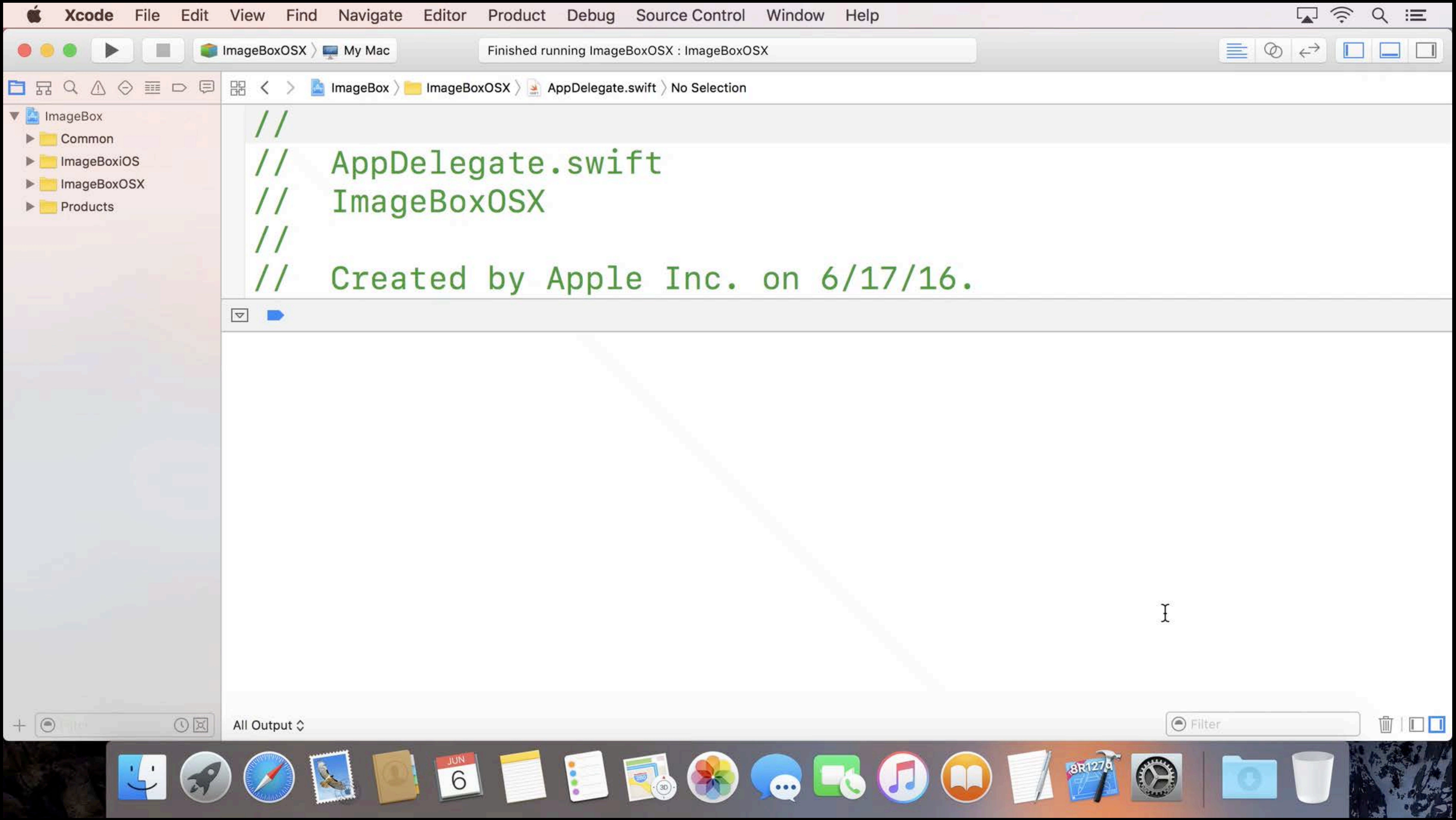
Name	Value
No Environment Variables	

Expand Variables Based On: ImageBoxOSX



Finished running ImageBoxOSX : ImageBoxOSX

```
//
//  AppDelegate.swift
//  ImageBoxOSX
//
//  Created by Apple Inc. on 6/17/16.
```



```
//
//  AppDelegate.swift
//  ImageBoxOSX
//
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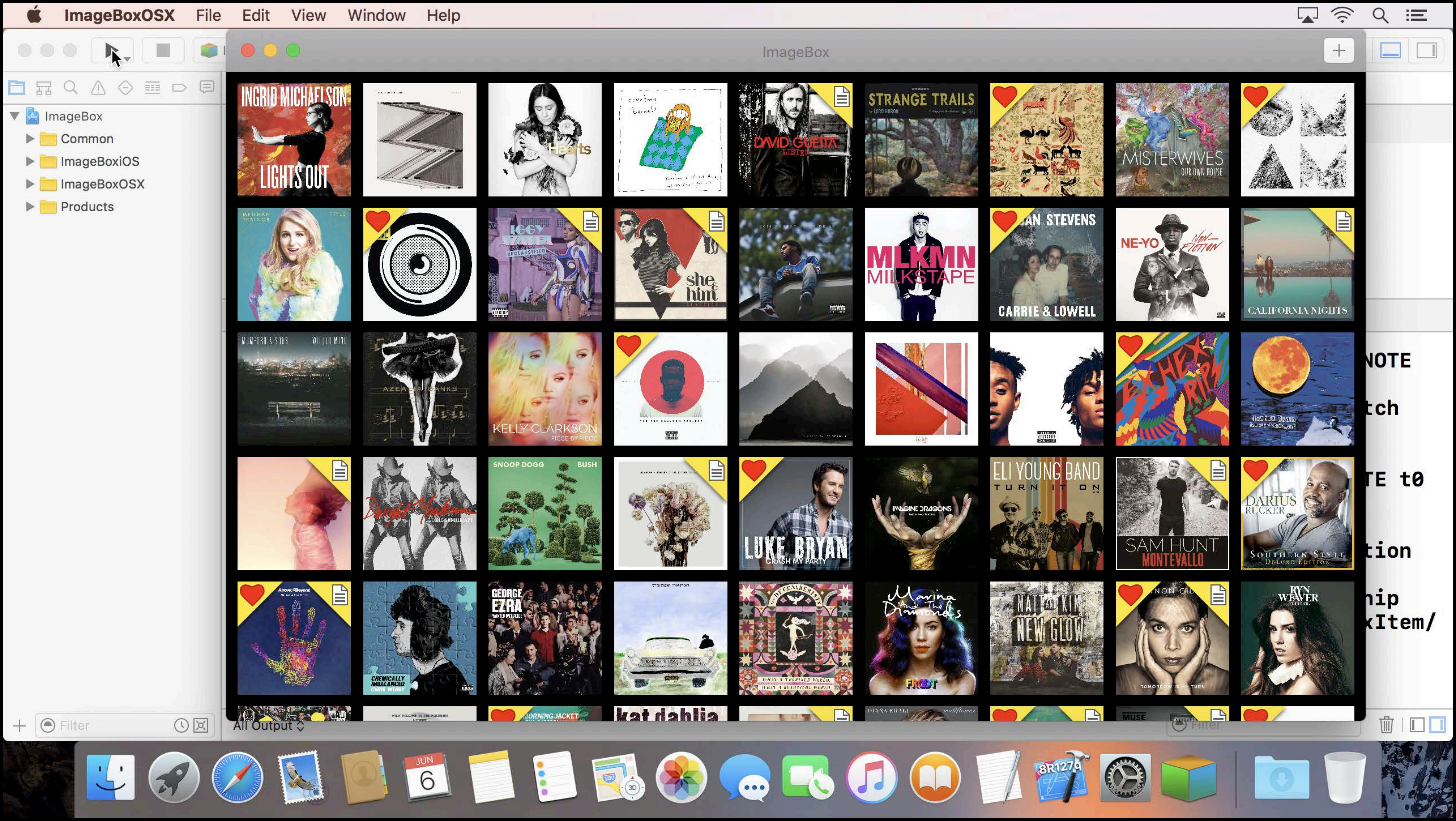
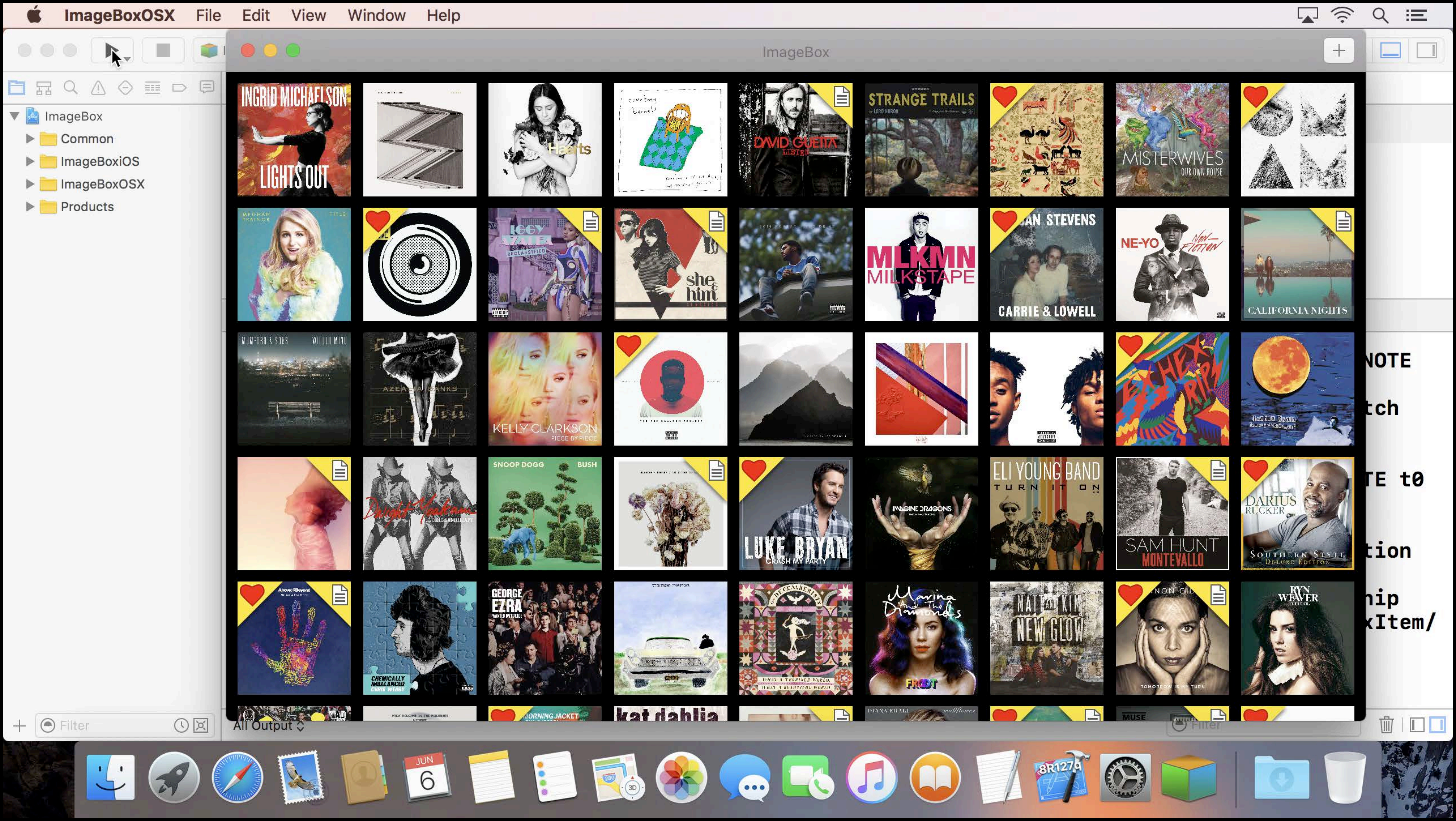
```


ImageBoxOSX
File
Edit
View
Window
Help
ImageBox
ImageBox
Common
ImageBoxiOS
ImageBoxOSX
Products
Filter
All Output


ImageBoxOSX
File
Edit
View
Window
Help
ImageBox
ImageBox
Common
ImageBoxiOS
ImageBoxOSX
Products
Filter
All Output
NOTE
tch
TE t0
tion
nip
xItem/

```
CoreData: annotation: fetch using NSSQLiteStatement <0x100e06de0> on entity 'BoxItem' with sql
text 'SELECT 0, t0.Z_PK, t0.Z_OPT, t0.ZFAVORITE, t0.ZIMAGEDATA, t0.ZLASTACCESSTIME FROM ZBOXITEM
t0 ' returned 100 rows with values

CoreData: annotation: total fetch execution time: 9.0923s for 100 rows.

CoreData: annotation: fetch using NSSQLiteStatement <0x100d6ded0> on entity 'Note' with sql text
'SELECT 0, t0.Z_PK FROM ZNOTE t0 WHERE  t0.ZBOXITEM = ? ' returned 1 rows with values: ( "0x640002b
<x-coredata://F2A95315-1A51-41B0-BE96-E84064F3505C/Note/p25>" )

CoreData: annotation: to-many relationship fault "notes" for objectID 0x4b <x-coredata://
F2A95315-1A51-41B0-BE96-E84064F3505C/BoxItem/p1> fulfilled from database.  Got 1 rows with values:
( "0x640002b <x-coredata://F2A95315-1A51-41B0-BE96-E84064F3505C/Note/p25>" )
```

```
CoreData: annotation: fetch using NSSQLiteStatement <0x100e06de0> on entity 'BoxItem' with sql
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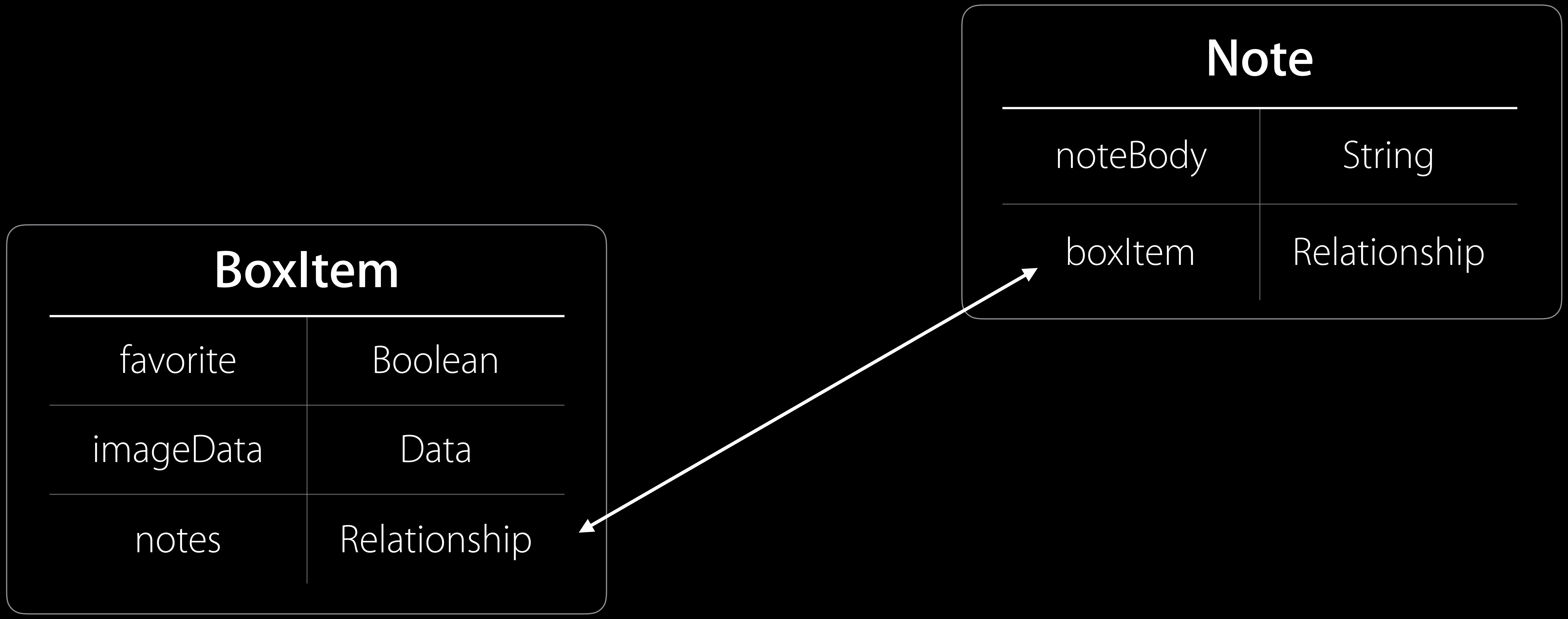
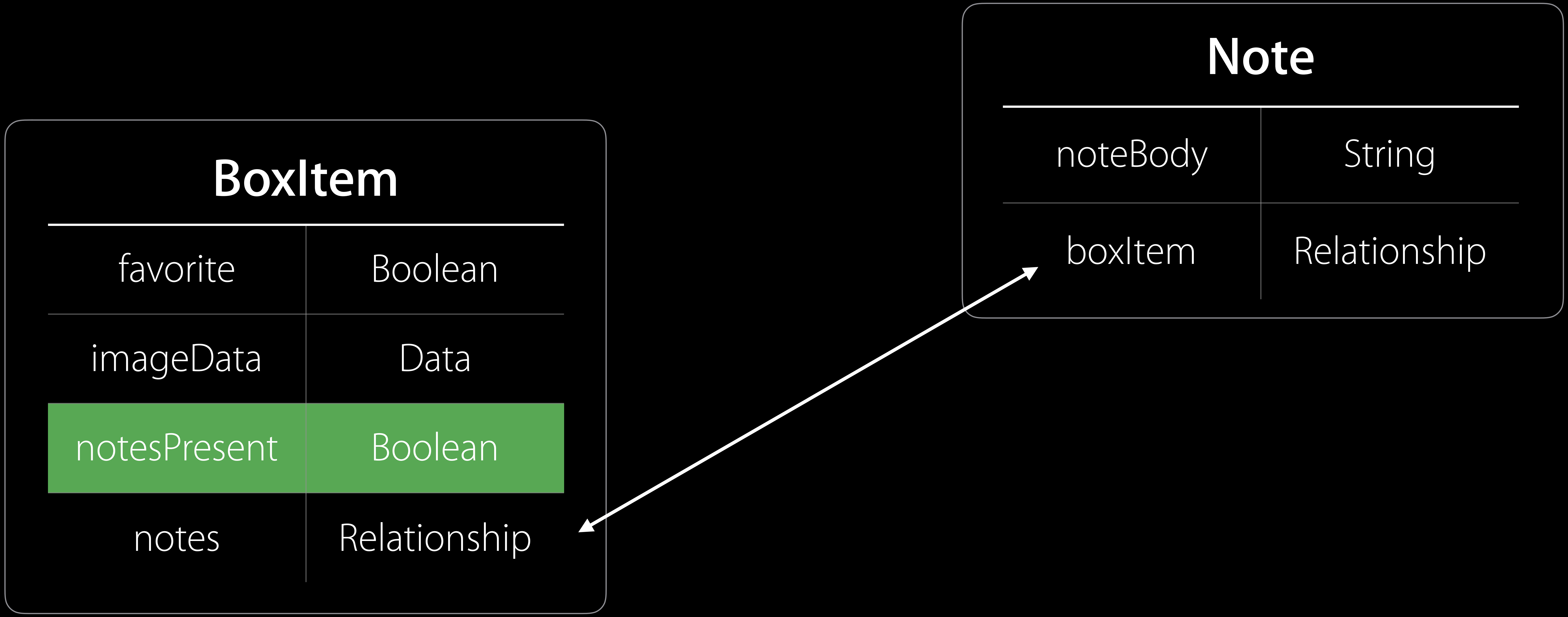
```

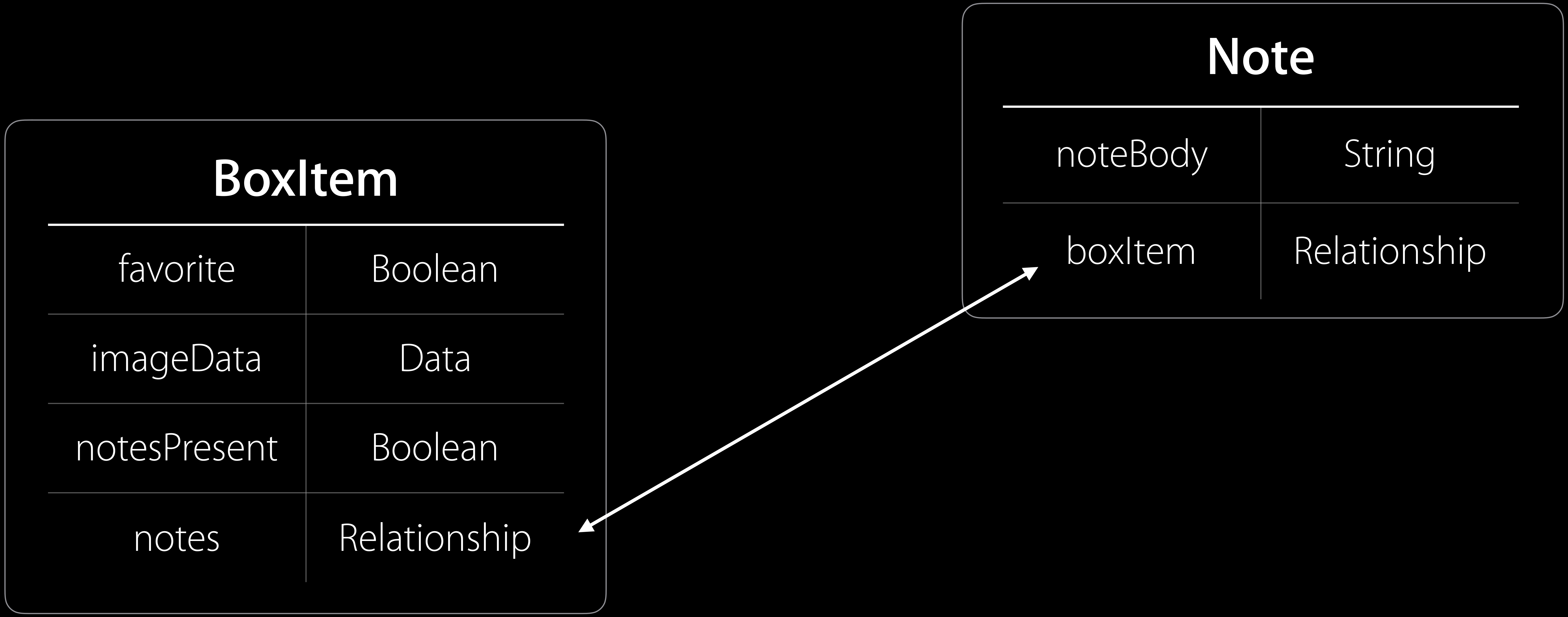
Improving Your Model



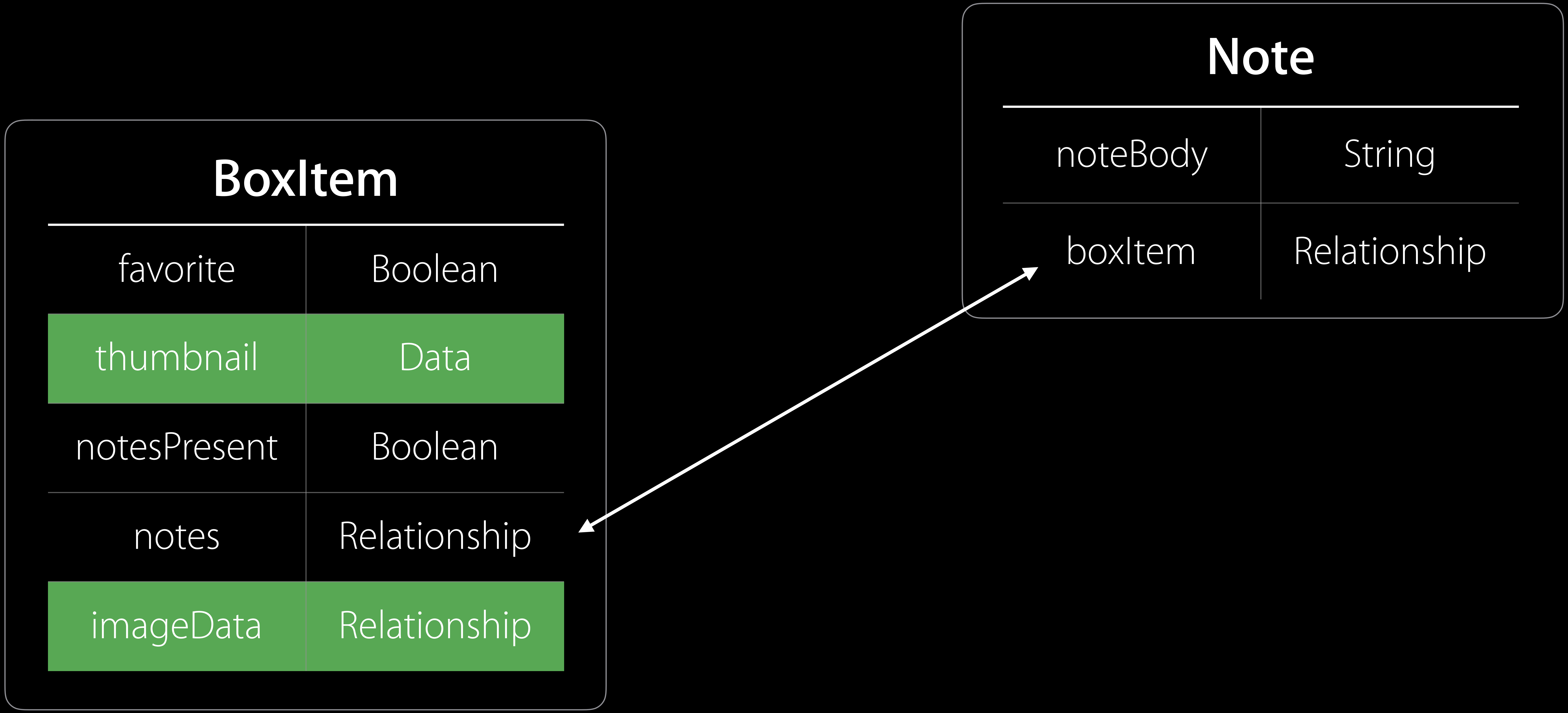
Improving Your Model



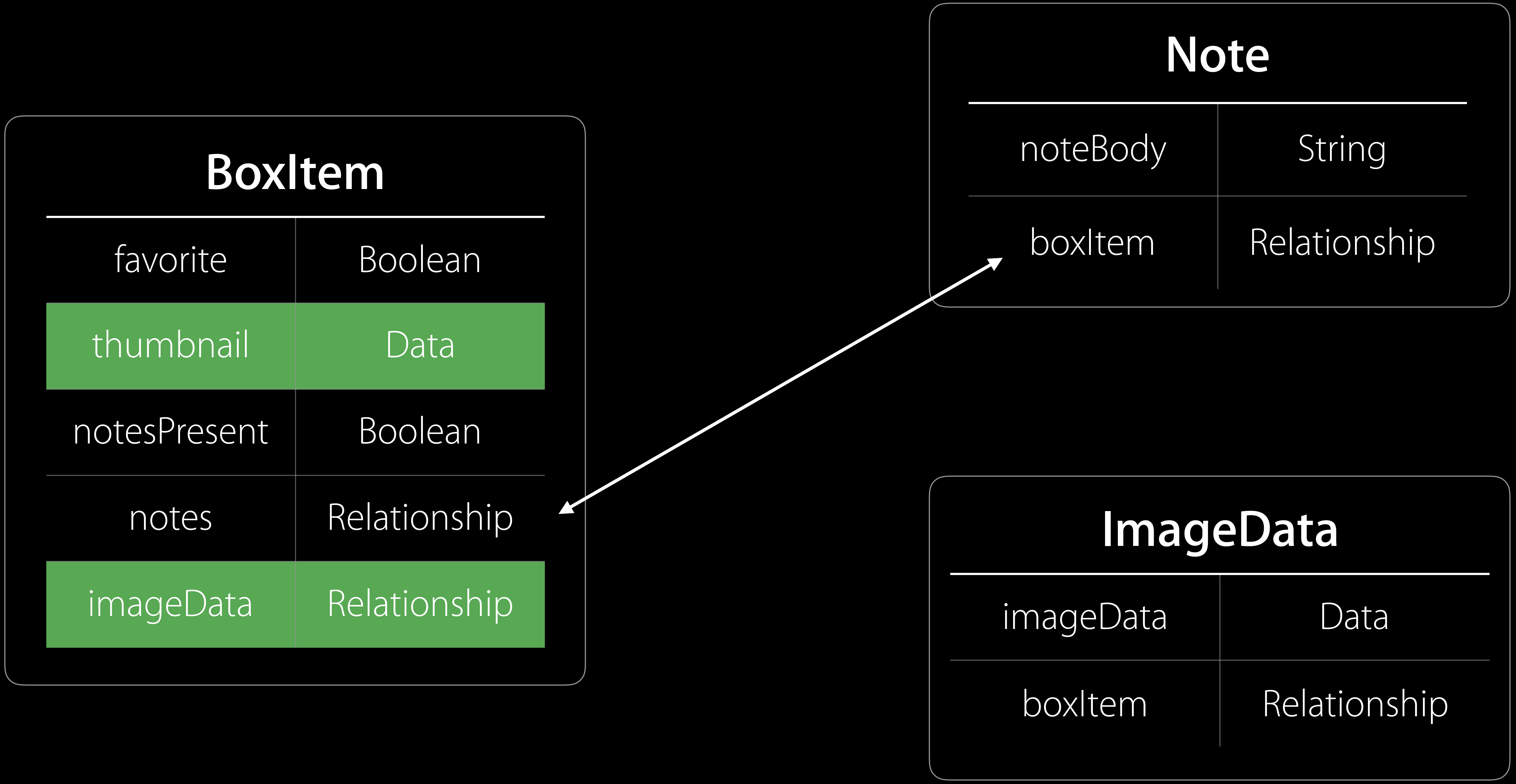
Improving Your Model



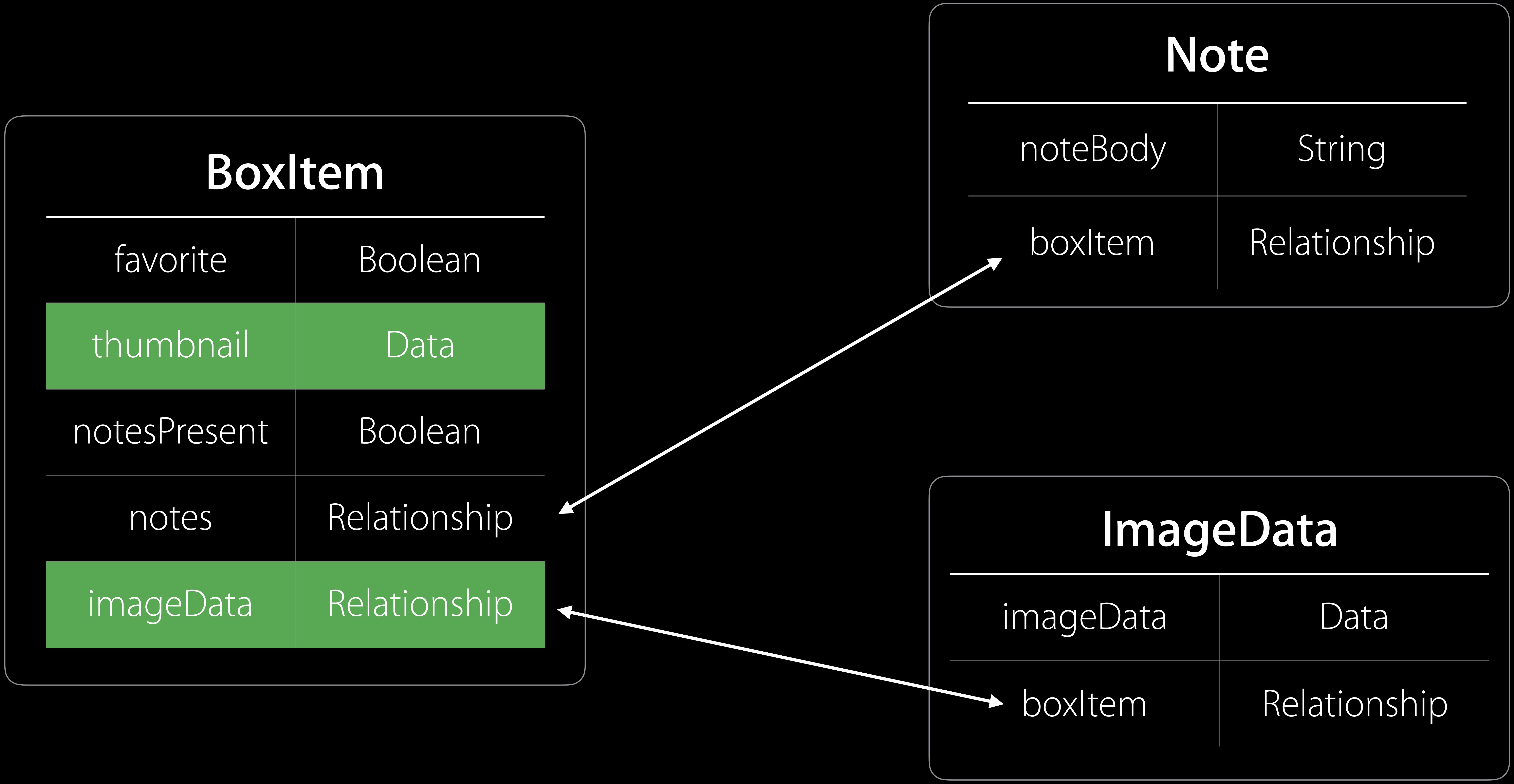
Improving Your Model



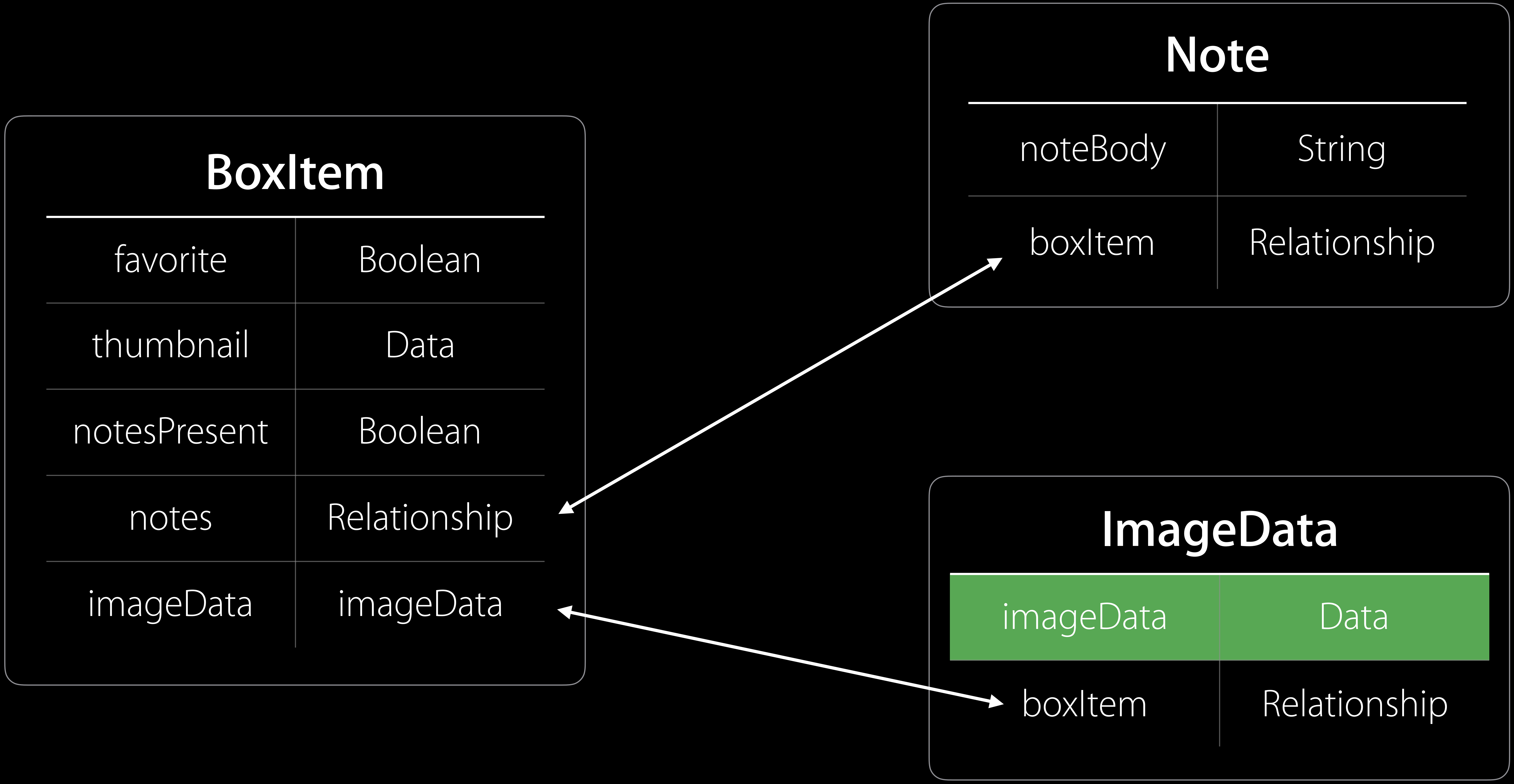
Improving Your Model



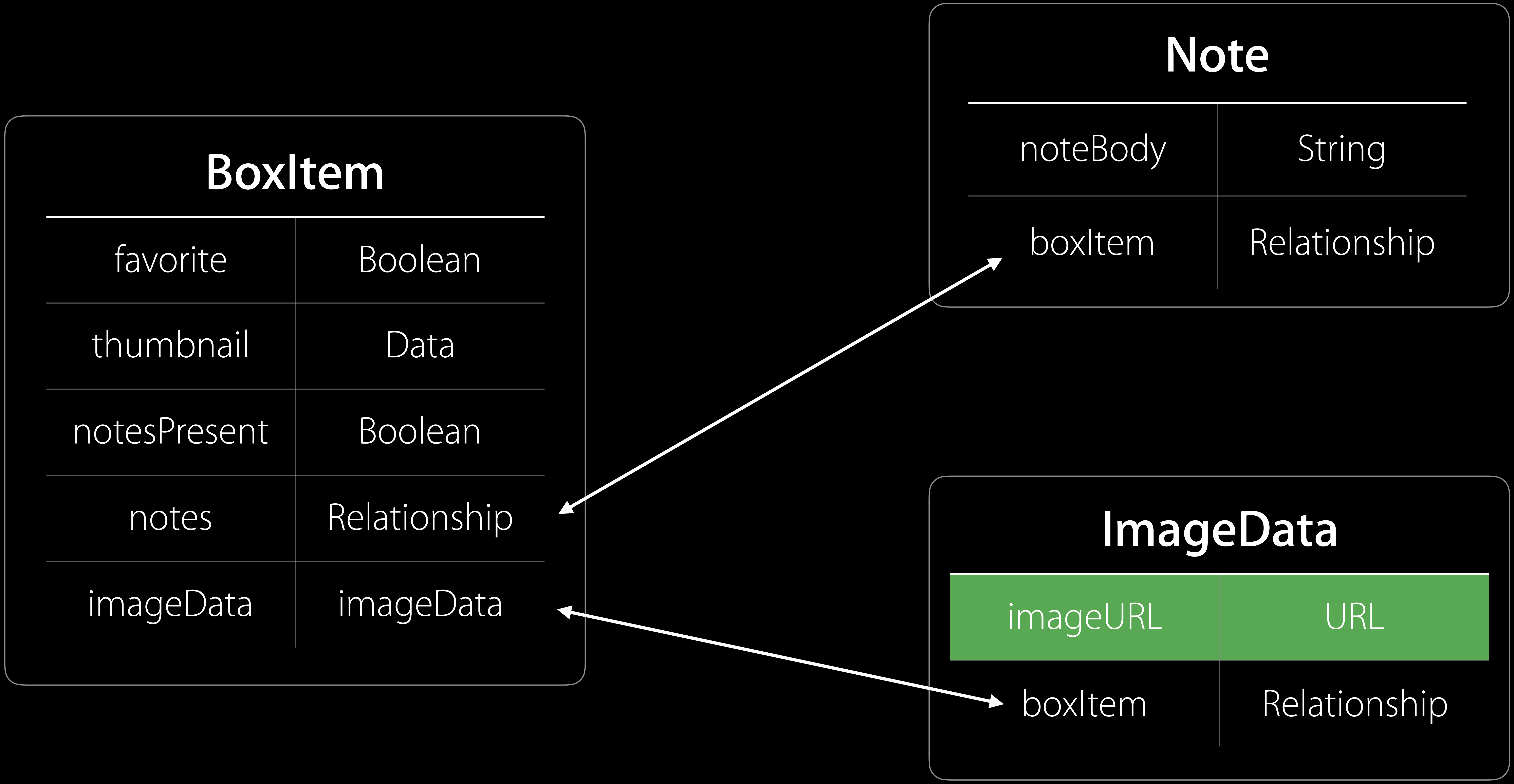
Improving Your Model

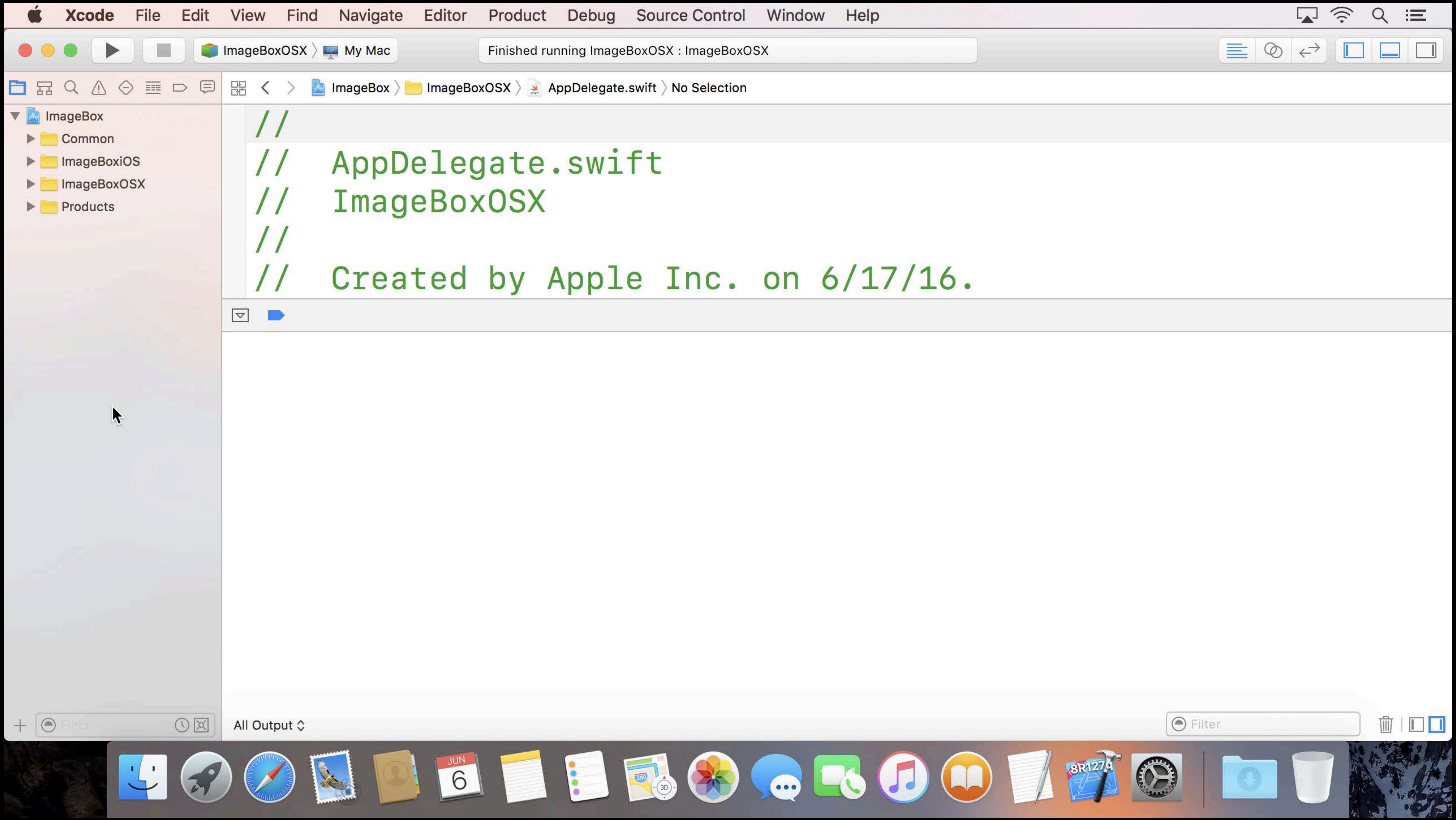


Improving Your Model

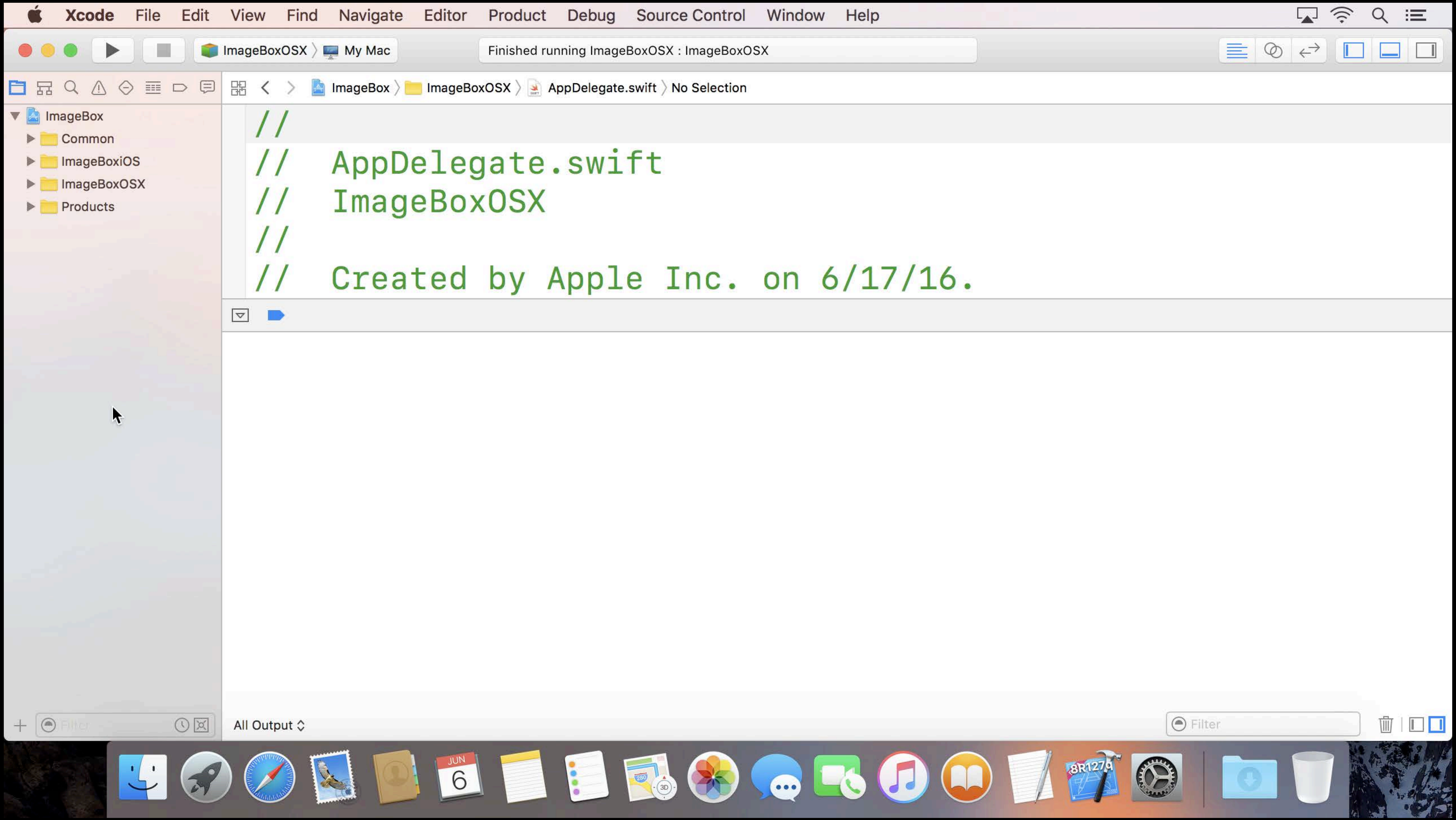


Improving Your Model





```
//
//  AppDelegate.swift
//  ImageBoxOSX
//
//  Created by Apple Inc. on 6/17/16.
```



```
//
//  AppDelegate.swift
//  ImageBoxOSX
//
//  Created by Apple Inc. on 6/17/16.
```

Test and Measure

Testing

Multiple/older devices

Testing

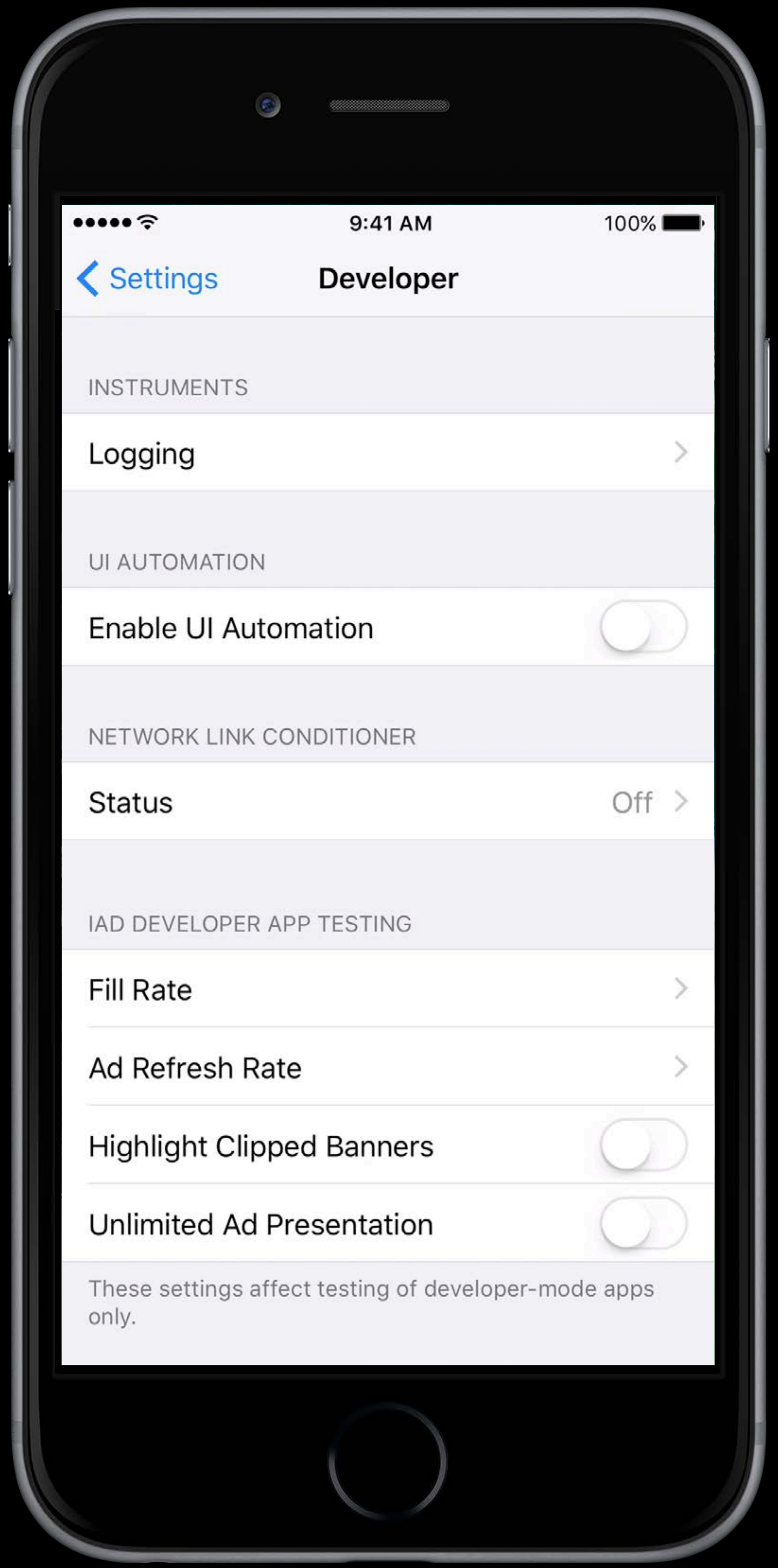
Varying network speeds

Testing

Varying network speeds

Testing

Varying network speeds


9:41 AM 100%

Settings Developer

INSTRUMENTS

Logging

UI AUTOMATION

Enable UI Automation

NETWORK LINK CONDITIONER

Status Off

IAD DEVELOPER APP TESTING

Fill Rate

Ad Refresh Rate

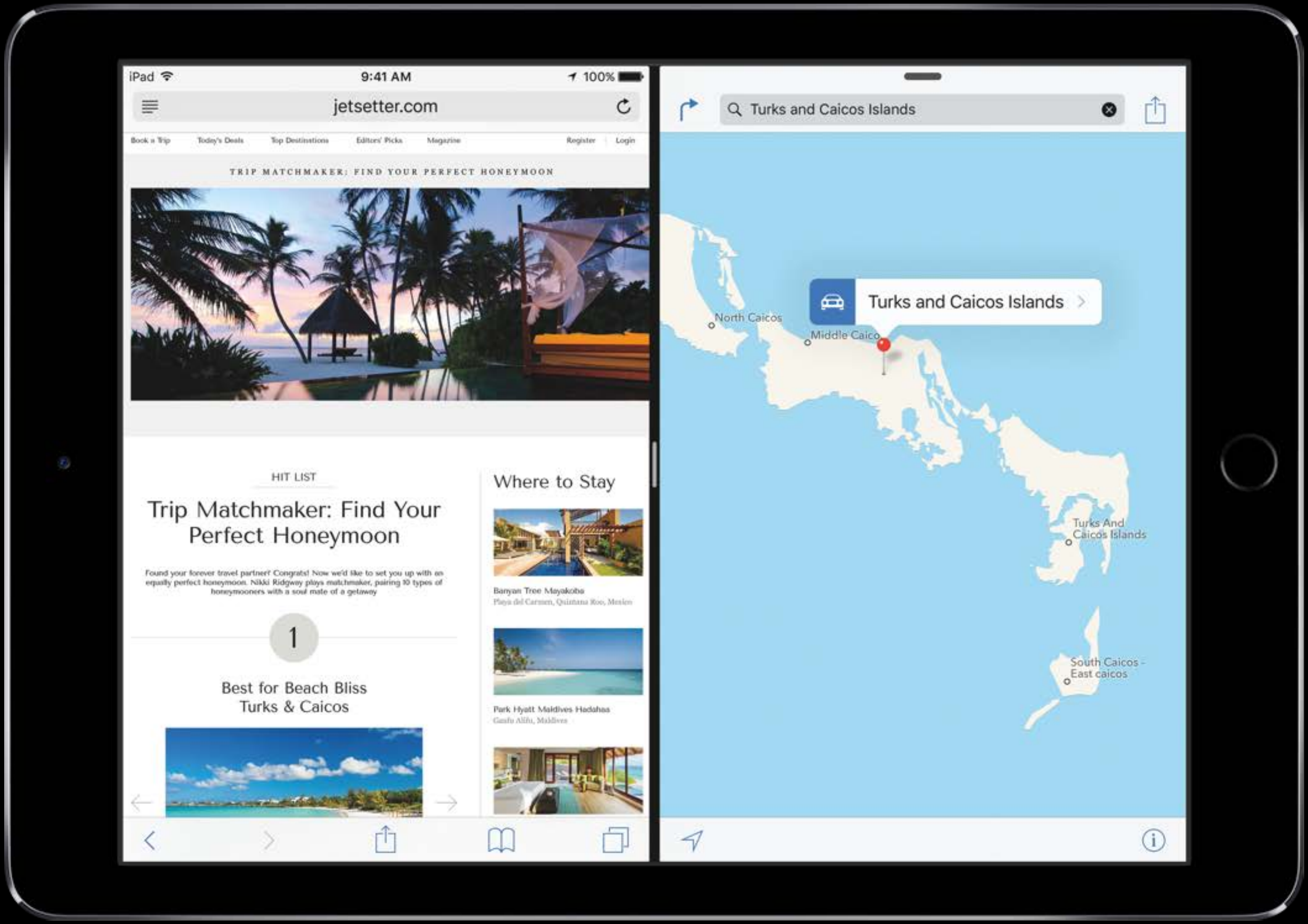
Highlight Clipped Banners

Unlimited Ad Presentation

These settings affect testing of developer-mode apps only.

Testing

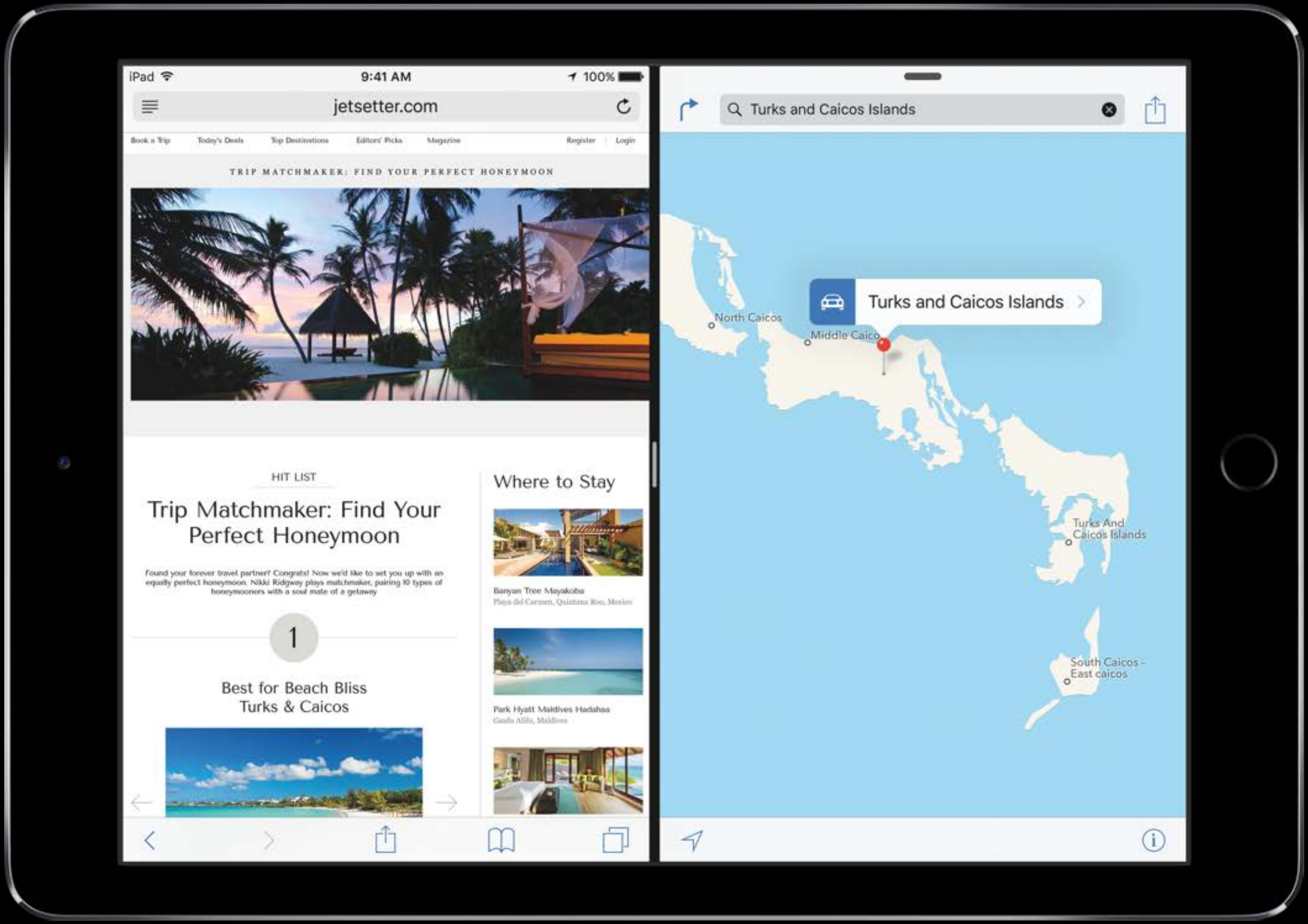
Environment variation



Testing

Environment variation

Multitasking

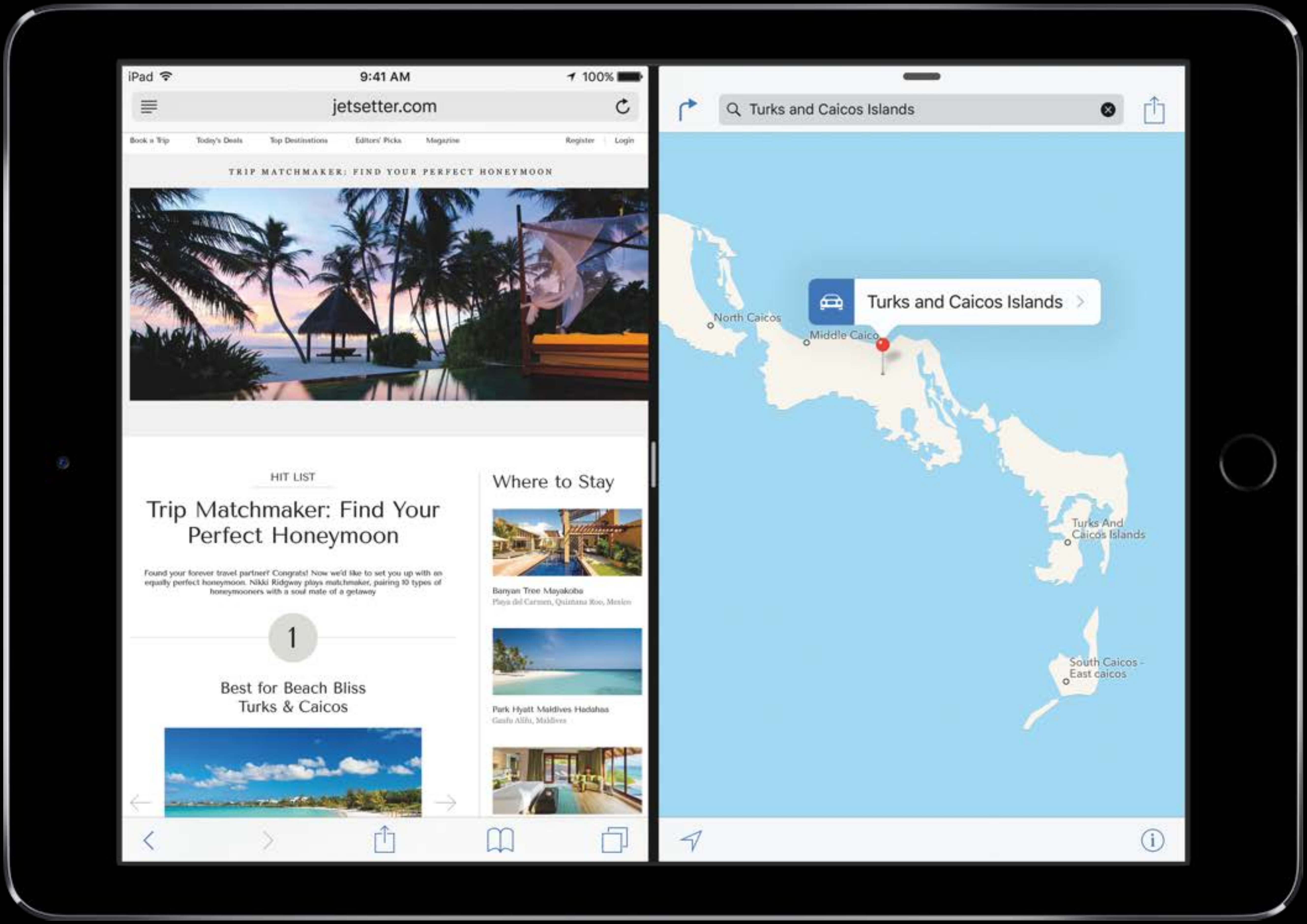


Testing

Environment variation

Multitasking

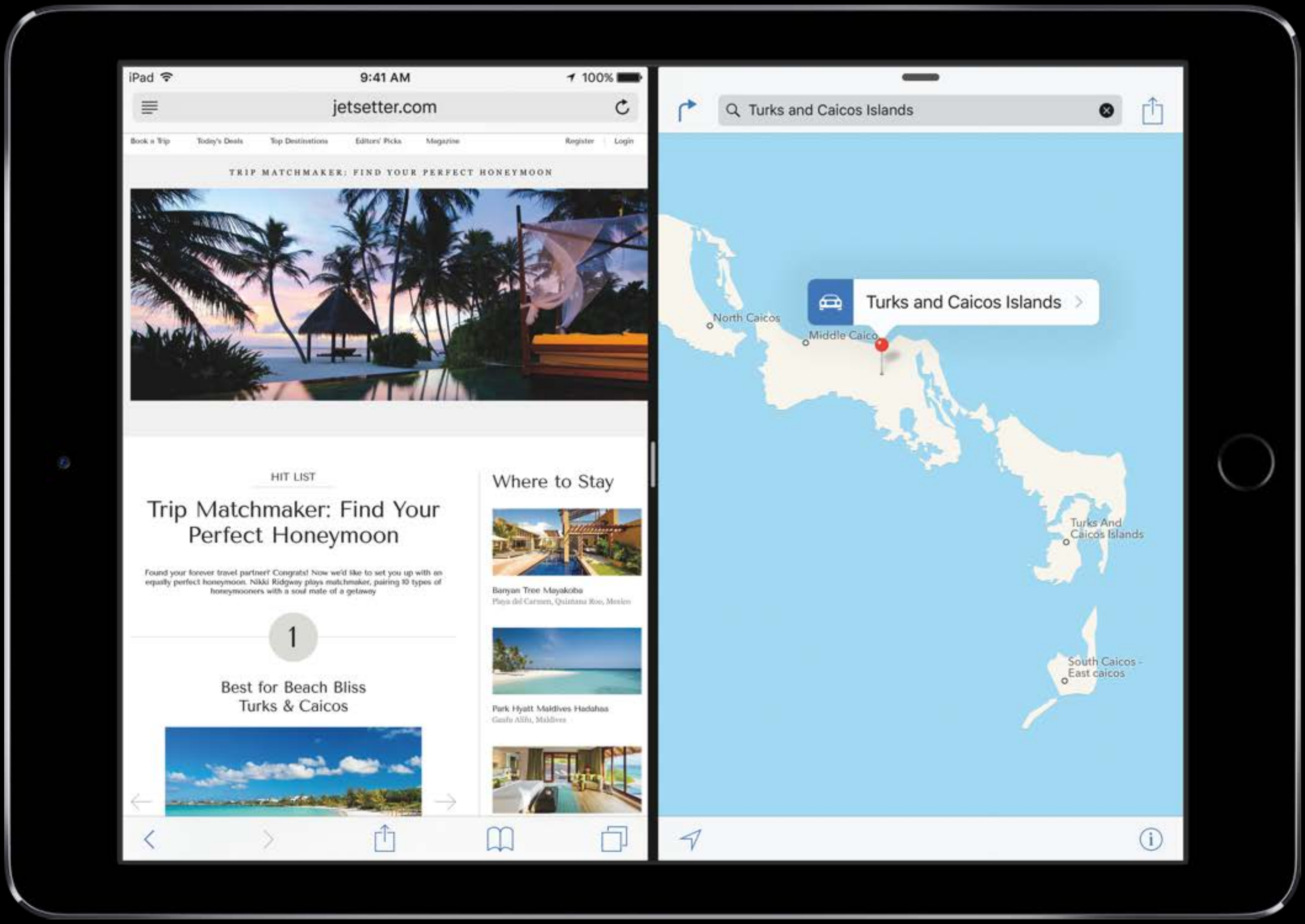
Memory pressure



Testing

Environment variation

- Multitasking
- Memory pressure
- Caches


jetsetter.com
TRIP MATCHMAKER: FIND YOUR PERFECT HONEYMOON
Trip Matchmaker: Find Your Perfect Honeymoon
Where to Stay
Best for Beach Bliss Turks & Caicos
Turks and Caicos Islands
North Caicos
Middle Caicos
South Caicos - East caicos

Testing

Environment variation

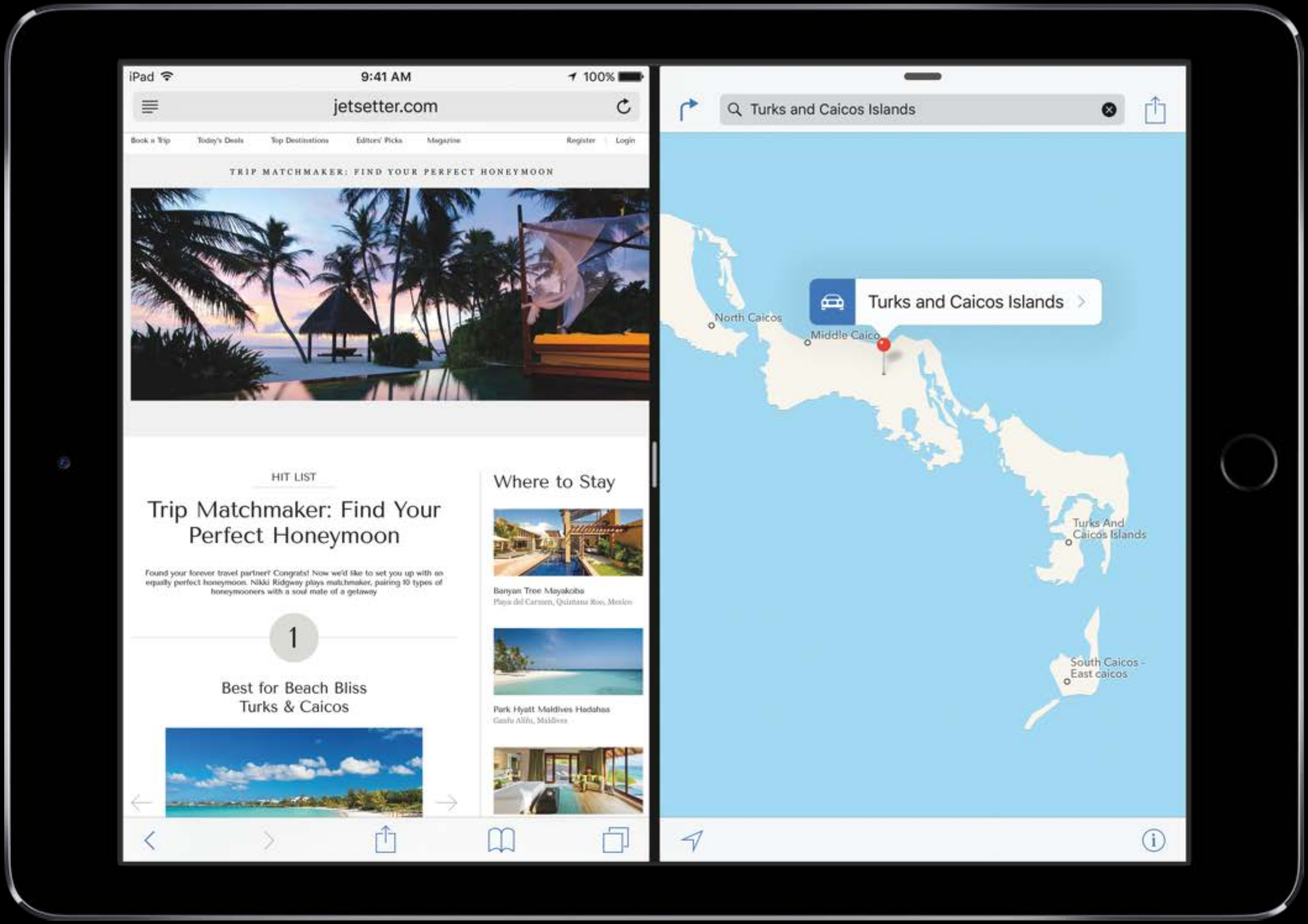
iOS

Multitasking

Memory pressure

Caches

- Reboot



Testing

Environment variation

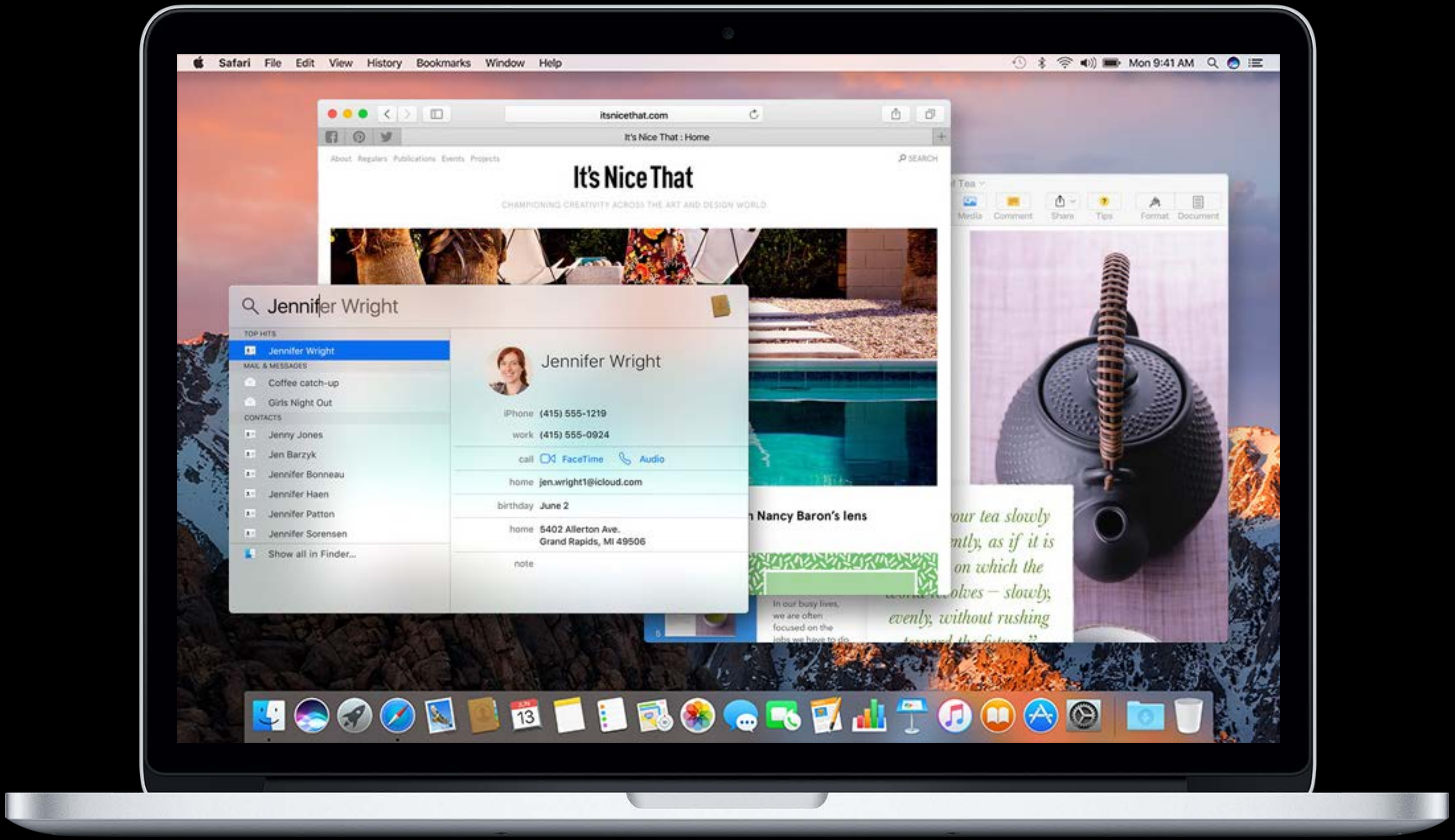
macOS

Multitasking

Memory pressure

Caches

- Reboot
- `purge`



Summary

Summary

I/O affects battery life

Summary

I/O affects battery life

Move work off the main thread

Summary

I/O affects battery life

Move work off the main thread

Specify proper quality of service

Summary

I/O affects battery life

Move work off the main thread

Specify proper quality of service

Switch to Asset Catalogs

Summary

I/O affects battery life

Move work off the main thread

Specify proper quality of service

Switch to Asset Catalogs

Use Core Data

Summary

I/O affects battery life

Move work off the main thread

Specify proper quality of service

Switch to Asset Catalogs

Use Core Data

Test and measure

More Information

https://developer.apple.com/wwdc16/719

Related Sessions

Optimizing App Startup Time	Mission	Wednesday 10:00AM
System Trace in Depth	Nob Hill	Thursday 9:00AM
Architecting for Performance on watchOS 3	Mission	Thursday 3:00PM
What’s New in Core Data	Pacific Heights	Friday 10:00AM
Using Time Profiler in Instruments	Nob Hill	Friday 3:00PM
Concurrent Programming with GCD in Swift 3	Pacific Heights	Friday 4:00PM

Labs

Core Data Lab	Frameworks Lab D	Friday 11:00AM
GCD Lab	Frameworks Lab D	Friday 5:00PM

WWDC16