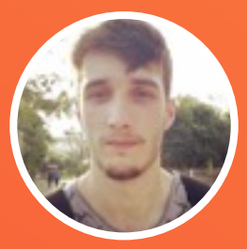
Swift: Gerenciamento de Memória



Txai Wieser

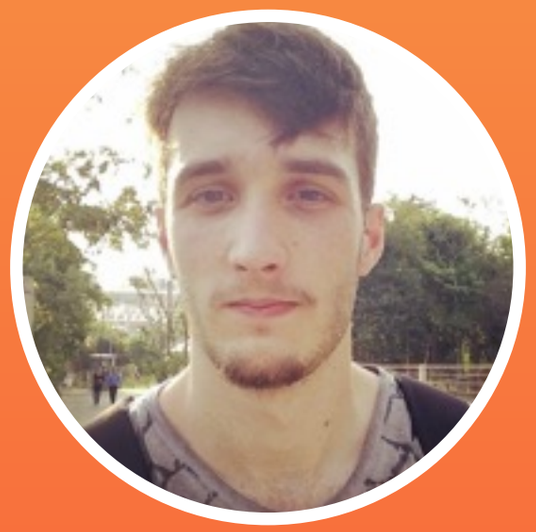
Repel

Recolorindo o Reino

Warren

FityIt

Ballphy



Txai Wieser

- Estudante de engenharia de computação na UFRGS.
- Desenvolvedor iOS

Swift: Gerenciamento de Memória

Gerenciador de Memória

MANUAL  AUTOMÁTICO

Gerenciador de Memória

MANUAL  AUTOMÁTICO

Programador

release

retain

alloc

Gerenciador de Memória

malloc

ObjectAlloc

heap

MallocScribble

MANUAL ⟷ AUTOMÁTICO

Programador

autorelease

__unsafe_unretained

free

release

autoreleasepool

__autoreleasing

destroy

retain

alloc

vmmap

assign

copy

Gerenciador de Memória

malloc

ObjectAlloc

heap

MallocScribble

MANUAL ⟷ AUTOMÁTICO

Programador

autorelease

__unsafe_unretained

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destroy

retain

alloc

vmmap

assign

copy

Gerenciador de Memória

Programador

Garbage Collector

Gerenciador de Memória

MANUAL  AUTOMÁTICO

Programador

(-)trabalhoso

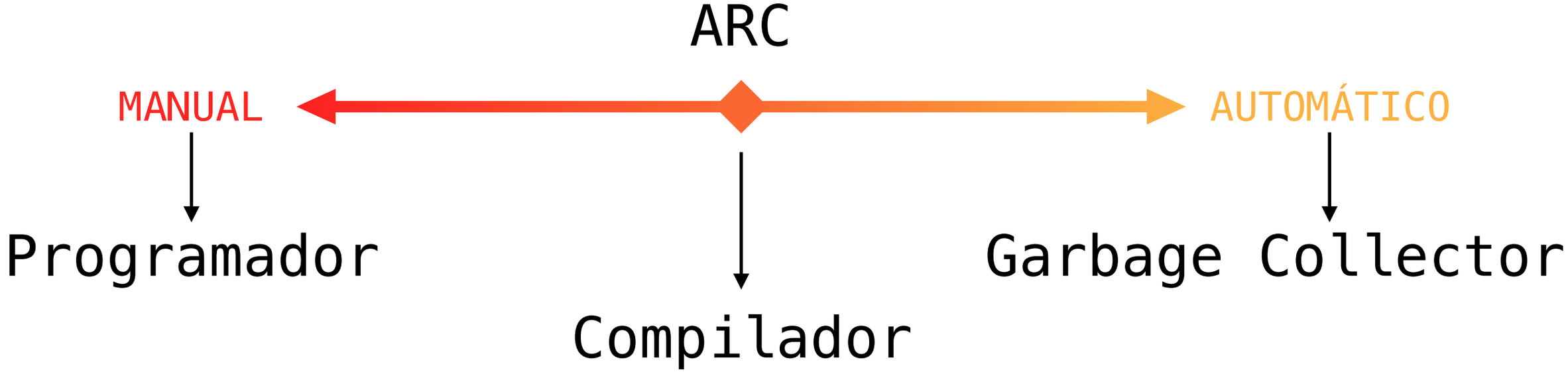
(+)determinístico

Garbage Collector

(-)afeta o runtime

(+)automático

Gerenciador de Memória



ARC

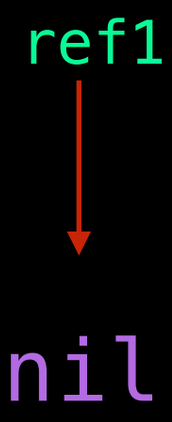
Reference counting is a technique of storing the number of references, pointers, or handles to a resource such as an object, block of memory, disk space or other resource. It may also refer, more specifically, to a garbage collection algorithm that uses these reference counts to deallocate objects which are no longer referenced.

Garbage Collector

Tracing garbage collection is a form of automatic memory management that consists of determining which objects should be deallocated by tracing which objects are reachable by a chain of references from certain “root” objects, and considering the rest as “garbage” and collecting them.

Automatic Reference Counting strong

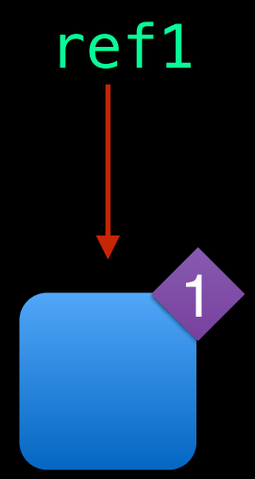
```
class Pessoa { }

var ref1: Pessoa?
```



Automatic Reference Counting

strong

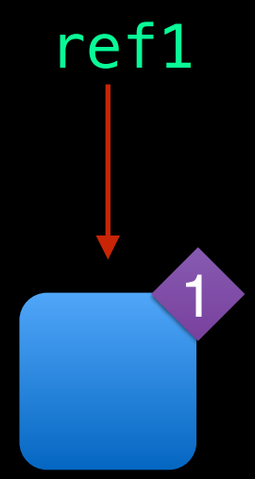
```
class Pessoa { }

var ref1: Pessoa?

ref1 = Pessoa()
```



Automatic Reference Counting

strong

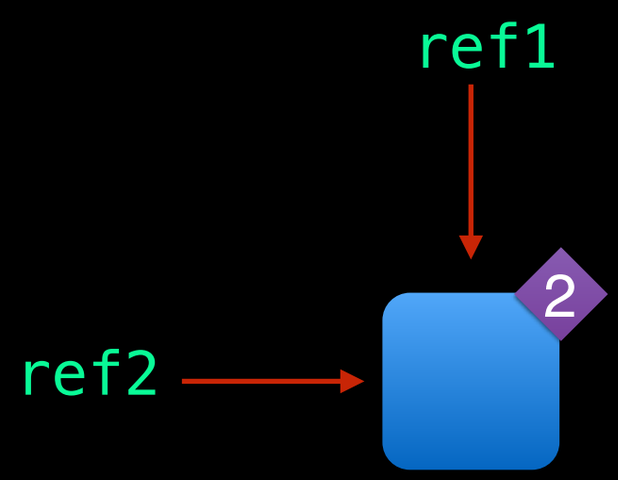
```
class Pessoa { }

var ref1: Pessoa?

ref1 = Pessoa()

var ref2: Pessoa?
```



Automatic Reference Counting

strong

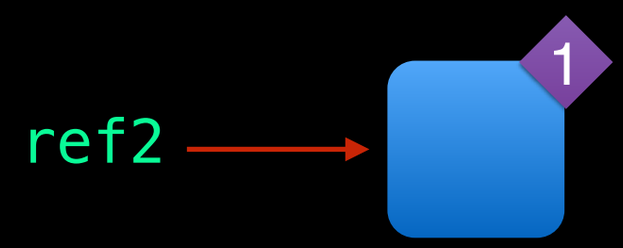
```
class Pessoa { }

var ref1: Pessoa?

ref1 = Pessoa()

var ref2: Pessoa?

ref2 = ref1
```



Automatic Reference Counting

strong

```
class Pessoa { }

var ref1: Pessoa?

ref1 = Pessoa()

var ref2: Pessoa?

ref2 = ref1


ref1 = nil
```



Automatic Reference Counting

strong

```swift
class Pessoa { }

var ref1: Pessoa?

ref1 = Pessoa()

var ref2: Pessoa?

ref2 = ref1


ref1 = nil

ref2 = nil
```

Automatic Reference Counting

strong

```
class Pessoa { }

var ref1: Pessoa?
ref1 = Pessoa()

var ref2: Pessoa?
ref2 = ref1

ref1 = nil

ref2 = nil
```

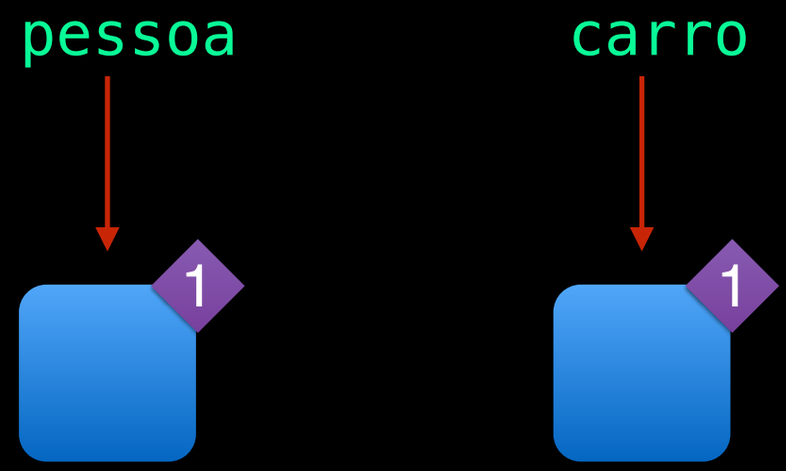
ref1

ref2

Ciclos de Referências

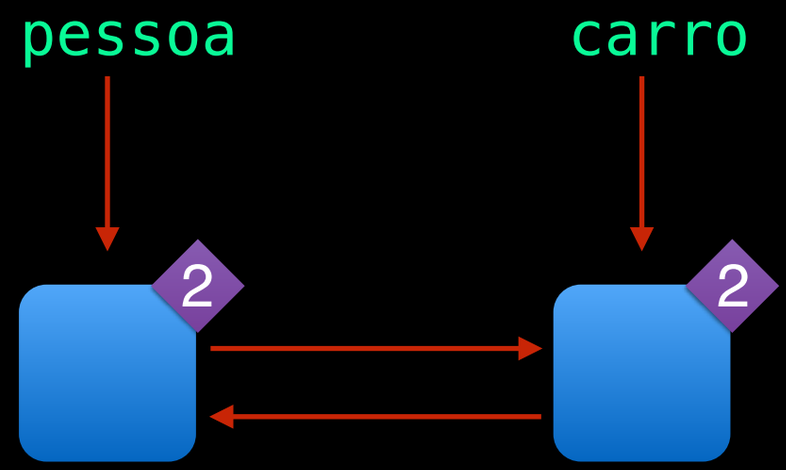
ARC (Vida Independente) weak

```
class Pessoa {
    var veículo: Carro?
}

class Carro {
    var proprietário:Pessoa?
}

var pessoa: Pessoa? = Pessoa()
var carro: Carro? = Carro()
```



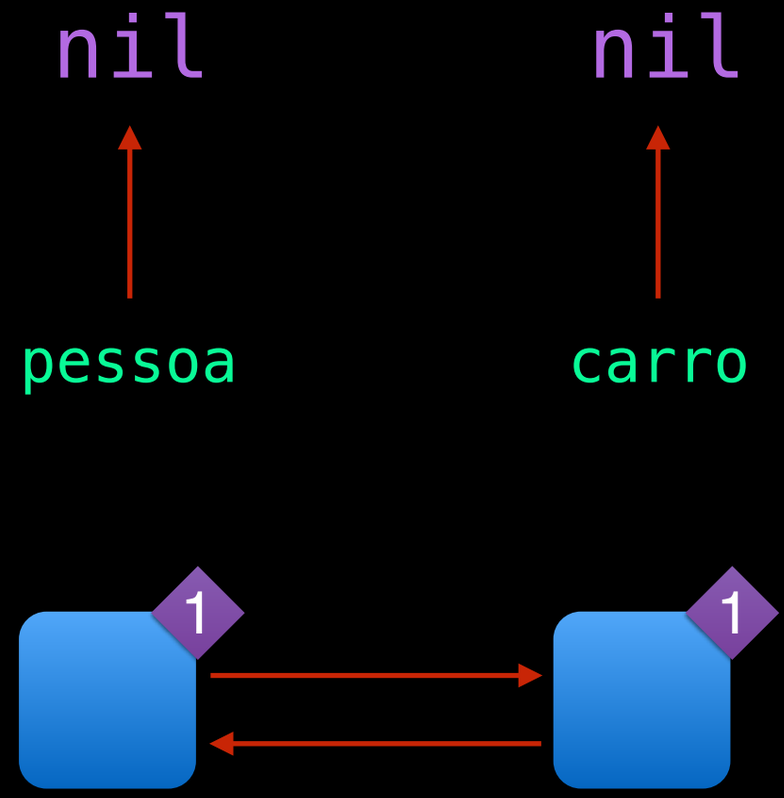
ARC (Vida Independente) weak

```
class Pessoa {
    var veículo: Carro?
}

class Carro {
    var proprietário:Pessoa?
}

var pessoa: Pessoa? = Pessoa()
var carro: Carro? = Carro()

pessoa!.veículo = carro
carro!.proprietário = pessoa
```



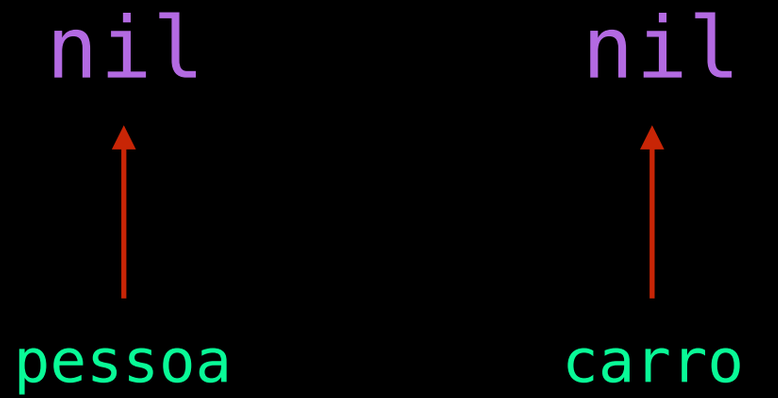
ARC (Vida Independente) weak

```
class Pessoa {
    var veículo: Carro?
}

class Carro {
    var proprietário:Pessoa?
}

var pessoa: Pessoa? = Pessoa()
var carro: Carro? = Carro()

pessoa!.veículo = carro
carro!.proprietário = pessoa


carro = nil
pessoa = nil
```



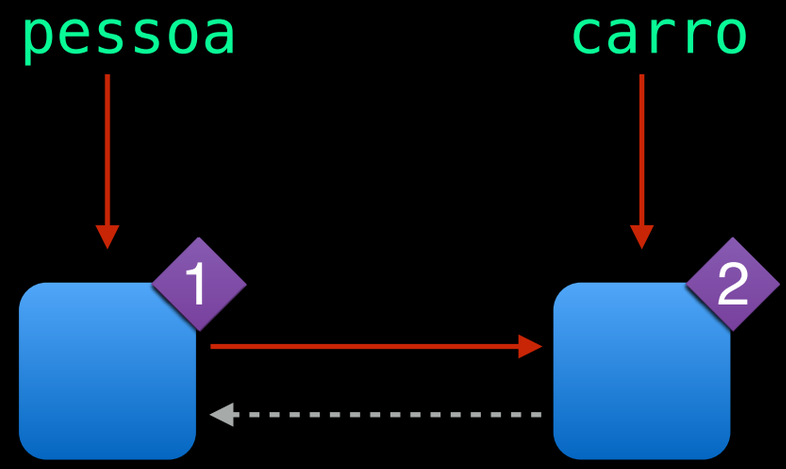
ARC (Vida Independente) weak

```
class Pessoa {
    var veículo: Carro?
}

class Carro {
    var proprietário:Pessoa?
}

var pessoa: Pessoa? = Pessoa()
var carro: Carro? = Carro()

pessoa!.veículo = carro
carro!.proprietário = pessoa


carro = nil
pessoa = nil
```



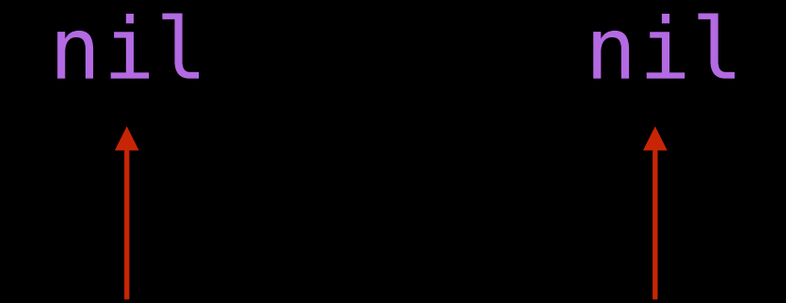
ARC (Vida Independente) weak

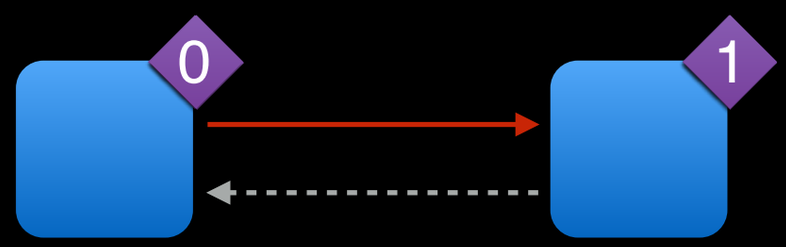
```
class Pessoa {
    var veículo: Carro?
}

class Carro {
    weak var proprietário:Pessoa?
}

var pessoa: Pessoa? = Pessoa()
var carro: Carro? = Carro()

pessoa!.veículo = carro
carro!.proprietário = pessoa


carro = nil
pessoa = nil
```



ARC (Vida Independente) weak

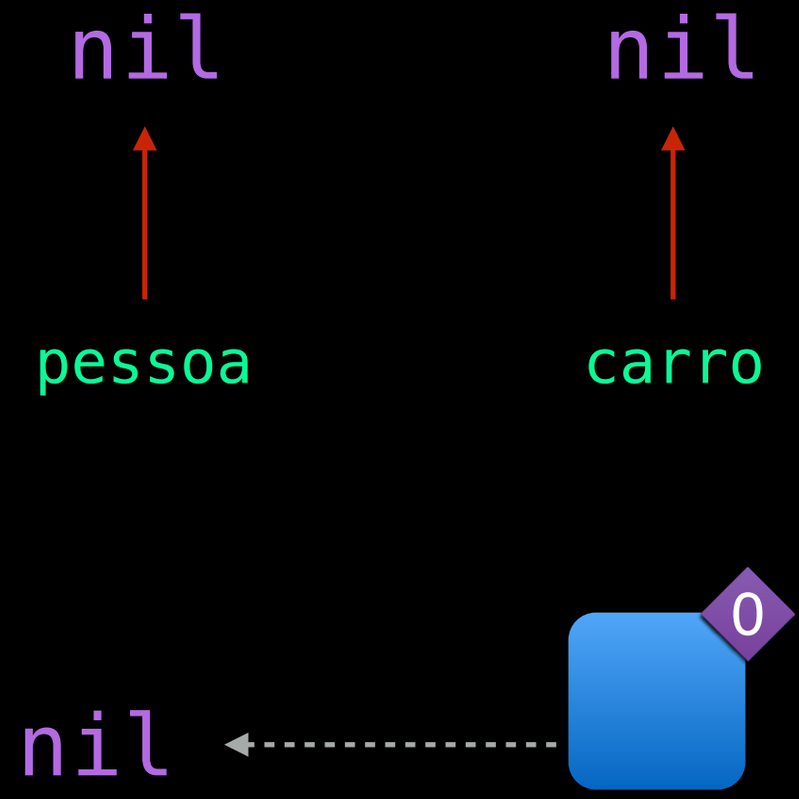
```
class Pessoa {
    var veículo: Carro?
}

class Carro {
    weak var proprietário:Pessoa?
}

var pessoa: Pessoa? = Pessoa()
var carro: Carro? = Carro()

pessoa!.veículo = carro
carro!.proprietário = pessoa


carro = nil
pessoa = nil
```





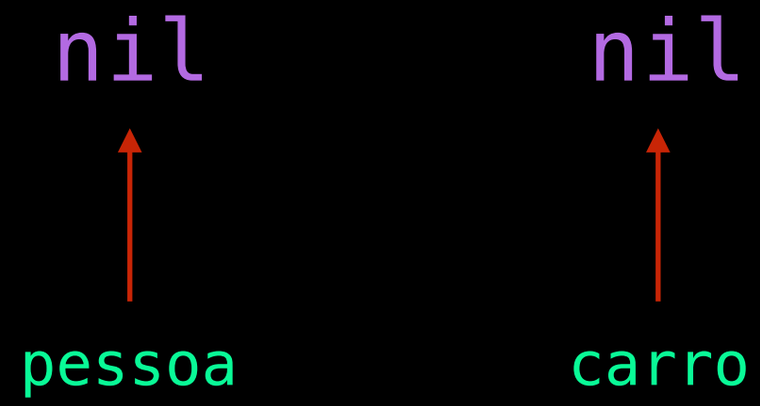
ARC (Vida Independente) weak

```
class Pessoa {
    var veículo: Carro?
}

class Carro {
    weak var proprietário:Pessoa?
}

var pessoa: Pessoa? = Pessoa()
var carro: Carro? = Carro()

pessoa!.veículo = carro
carro!.proprietário = pessoa


carro = nil
pessoa = nil
```



ARC (Vida Independente) weak

```
class Pessoa {
    var veículo: Carro?
}

class Carro {
    weak var proprietário:Pessoa?
}

var pessoa: Pessoa? = Pessoa()
var carro: Carro? = Carro()

pessoa!.veículo = carro
carro!.proprietário = pessoa


carro = nil
pessoa = nil
```

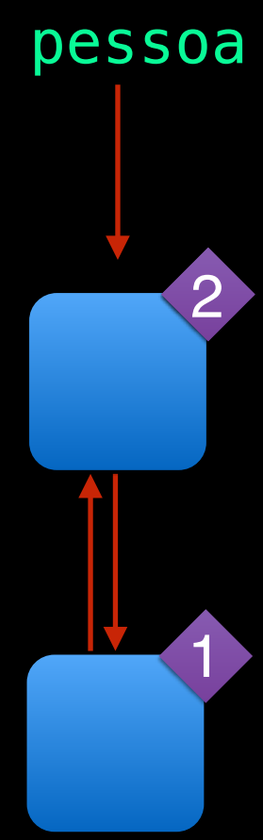


weak

(Vidas Independentes)

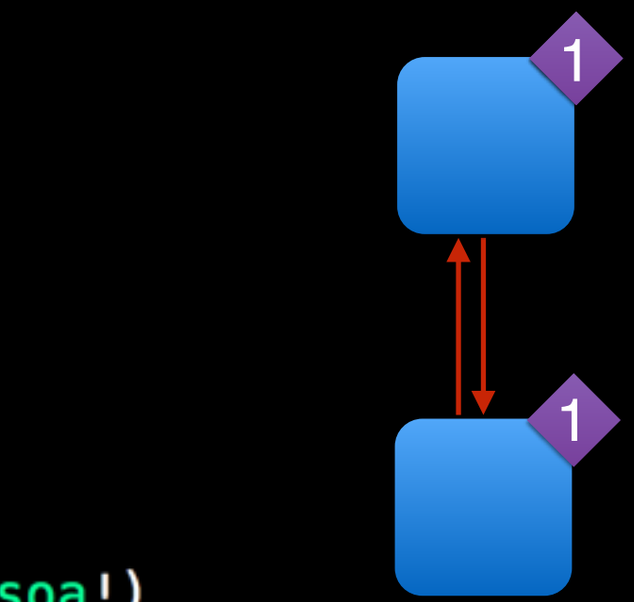
ARC (Vida Dependente) unowned

```swift
class Pessoa {
    var habilitação: Habilitação?
}

class Habilitação {
    let titular: Pessoa

    init(titular: Pessoa) {
        self.titular = titular
    }
}

var pessoa: Pessoa? = Pessoa()
pessoa!.habilitação = Habilitação(titular: pessoa!)
```



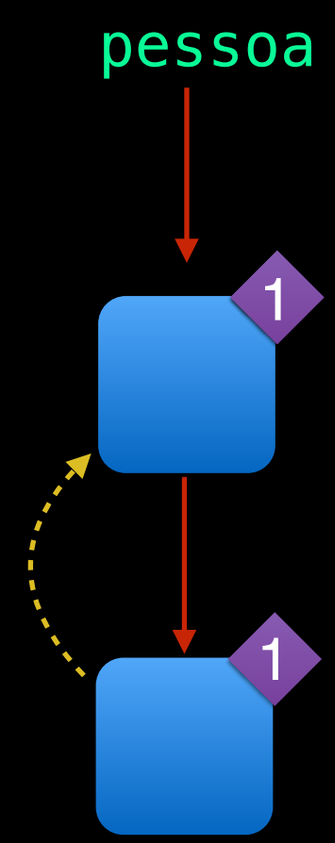
ARC (Vida Dependente) unowned

```swift
class Pessoa {
    var habilitação: Habilitação?
}

class Habilitação {
    let titular: Pessoa

    init(titular: Pessoa) {
        self.titular = titular
    }
}

var pessoa: Pessoa? = Pessoa()
pessoa!.habilitação = Habilitação(titular: pessoa!)

pessoa = nil
```



ARC (Vida Dependente) unowned

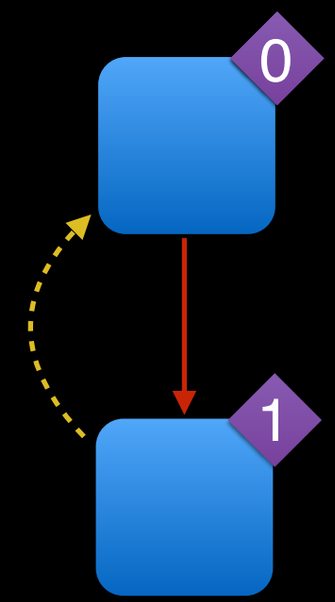
```swift
class Pessoa {
    var habilitação: Habilitação?
}

class Habilitação {
    unowned let titular: Pessoa

    init(titular: Pessoa) {
        self.titular = titular
    }
}

var pessoa: Pessoa? = Pessoa()
pessoa!.habilitação = Habilitação(titular: pessoa!)
```



ARC (Vida Dependente) unowned

```swift
class Pessoa {
    var habilitação: Habilitação?
}

class Habilitação {
    unowned let titular: Pessoa

    init(titular: Pessoa) {
        self.titular = titular
    }
}

var pessoa: Pessoa? = Pessoa()
pessoa!.habilitação = Habilitação(titular: pessoa!)

pessoa = nil
```

nil ← pessoa

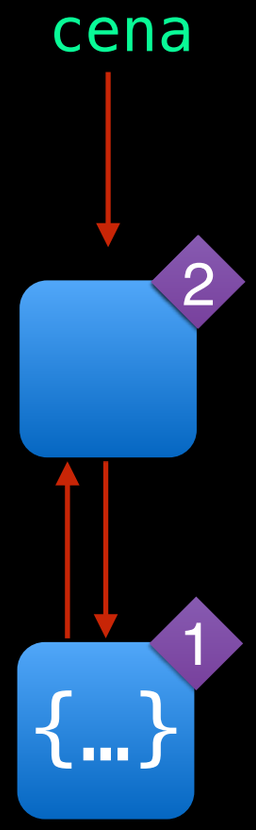


unowned

(Vida Dependente)

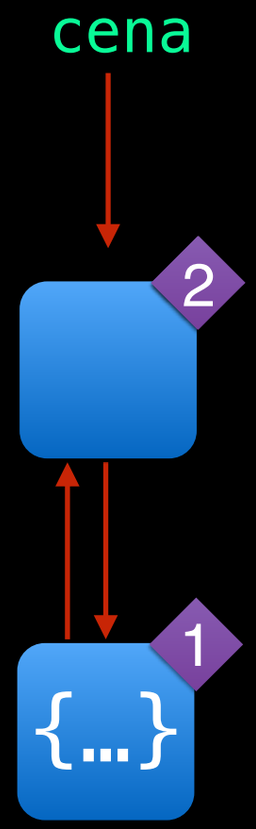
Closures

```
class Botão {
    var action: (()->())?
}

class Cena {
    let botão = Botão()
    var contagem = 0

    init() {
        botão.action = {
            contagem += 1
        }
    }
}


var cena:Cena? = Cena()
```



Closures

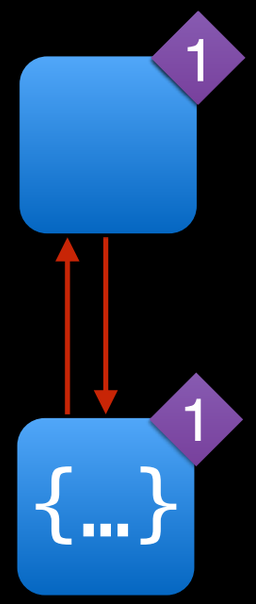
```
class Botão {
    var action: (()->())?
}

class Cena {
    let botão = Botão()
    var contagem = 0

    init() {
        botão.action = {
            self.contagem += 1
        }
    }
}

var cena:Cena? = Cena()
```



Closures

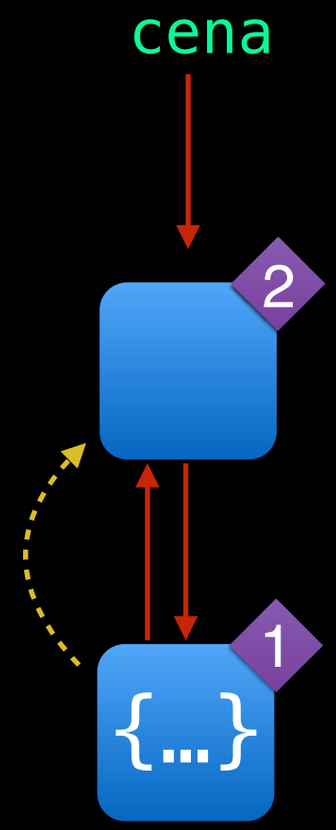
```
class Botão {
    var action: (()->())?
}

class Cena {
    let botão = Botão()
    var contagem = 0

    init() {
        botão.action = {
            self.contagem += 1
        }
    }
}


var cena:Cena? = Cena()

cena = nil
```

nil ← cena



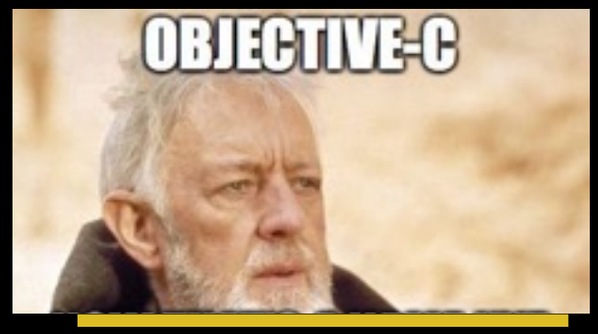
Closures

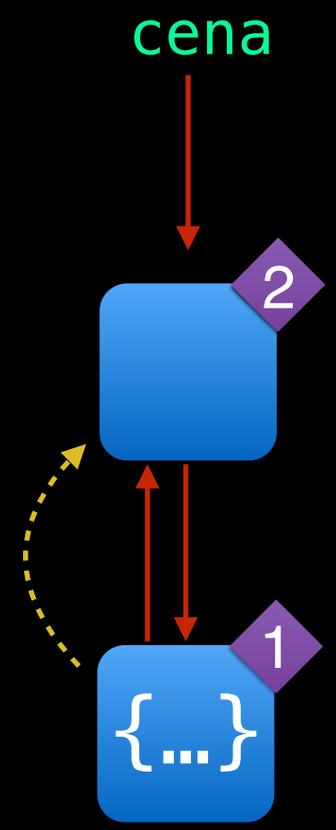
```
class Botão {
    var action: (()->())?
}

class Cena {
    let botão = Botão()
    var contagem = 0

    init() {
        self.botão.action = { [weak self] in
            self?.contagem += 1
        }
    }
}

var cena:Cena? = Cena()
```



Closures

```
class Botão {
    var action: (()->())?
}

class Cena {
    let botão = Botão()
    var contagem = 0

    init() {
        self.botão.action = { [weak self] in
            self?.contagem += 1
        }
    }
}


var cena:Cena? = Cena()
```





Closures

```
let closure: (()->())? = { [weak self] in
        if let strongSelf = self {
            strongSelf.view.alpha = 0.0
        }
    }
```

Closures

```
let resource = UIViewController()

let closure: (()->())? = { [weak self, weak resource] in
    if let strongSelf = self {
        strongSelf.view.alpha = 0.0
    }

    resource?.view.alpha = 0.0
}
```

Closures

(Lista de Captura)

Prevenção

Cuidado ⚠️

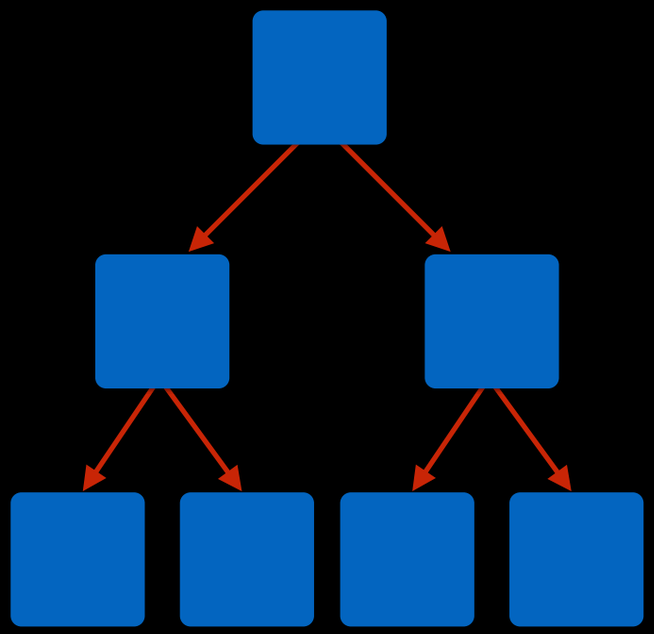
- Relações de Posse
- Referencias para classes
- Closures
  - NSTimer
  - UIAlertController

Use logs:

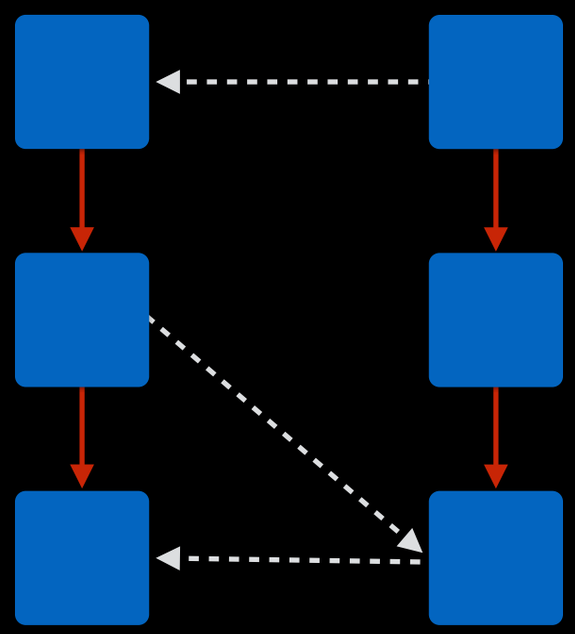
```
deinit {
    println("object is being deallocated")
}
```

```
-(void)dealloc
{
       NSLog(@"object is being deallocated");
}
```

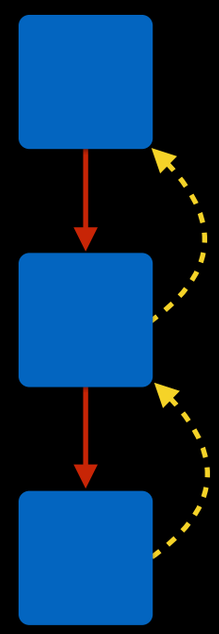
strong



weak



unowned



Value Types

Reference Types

debugging

Xcode File Edit View Find Navigate Editor Product Debug Source Control Window Help Qui 09 57 16 78%

ARC › iPhone 6 | Finished running - Profiling ARC.app on iPhone 6

ARC › ARC › ViewController.swift › M viewDidLoad()

- ARC
  - 2 targets, iOS SDK 8.3
  - ARC
    - AppDelegate.swift
    - ViewController.swift
    - Main.storyboard
    - Images.xcassets
    - LaunchScreen.xib
    - Supporting Files
  - ARCTests
  - Products

```swift
//
//  ViewController.swift
//  ARC
//
//  Created by Txai Wieser on 26/03/15.
//  Copyright (c) 2015 Txai Wieser. All rights reserved.
//

import UIKit


class Pessoa {
    var veículo:Carro?
}

class Carro {
    var proprietário:Pessoa?
}


class ViewController: UIViewController {

    override func viewDidLoad() {
        super.viewDidLoad()

        var pessoa:Pessoa? = Pessoa()
        var carro:Carro? = Carro()

        pessoa!.veículo = carro
        carro!.proprietário = pessoa
```

Xcode File Edit View Find Navigate Editor Product Debug Source Control Window Help Qui 09:57:35 78%

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Behaviors ▶

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Services ▶

Hide Xcode ⌘H
Hide Others ⌥⌘H
Show All

Quit Xcode ⌘Q

Instruments
iOS Simulator
Accessibility Inspector
FileMerge
Application Loader

More Developer Tools...

shed running - Profiling ARC.app on iPhone 6

ARC 〉 ARC 〉 ViewController.swift 〉 M viewDidLoad()

AppDelegate.swift
ViewController.swift
Main.storyboard
Images.xcassets
LaunchScreen.xib
Supporting Files
ARCTests
Products

```
iewController.swift
RC
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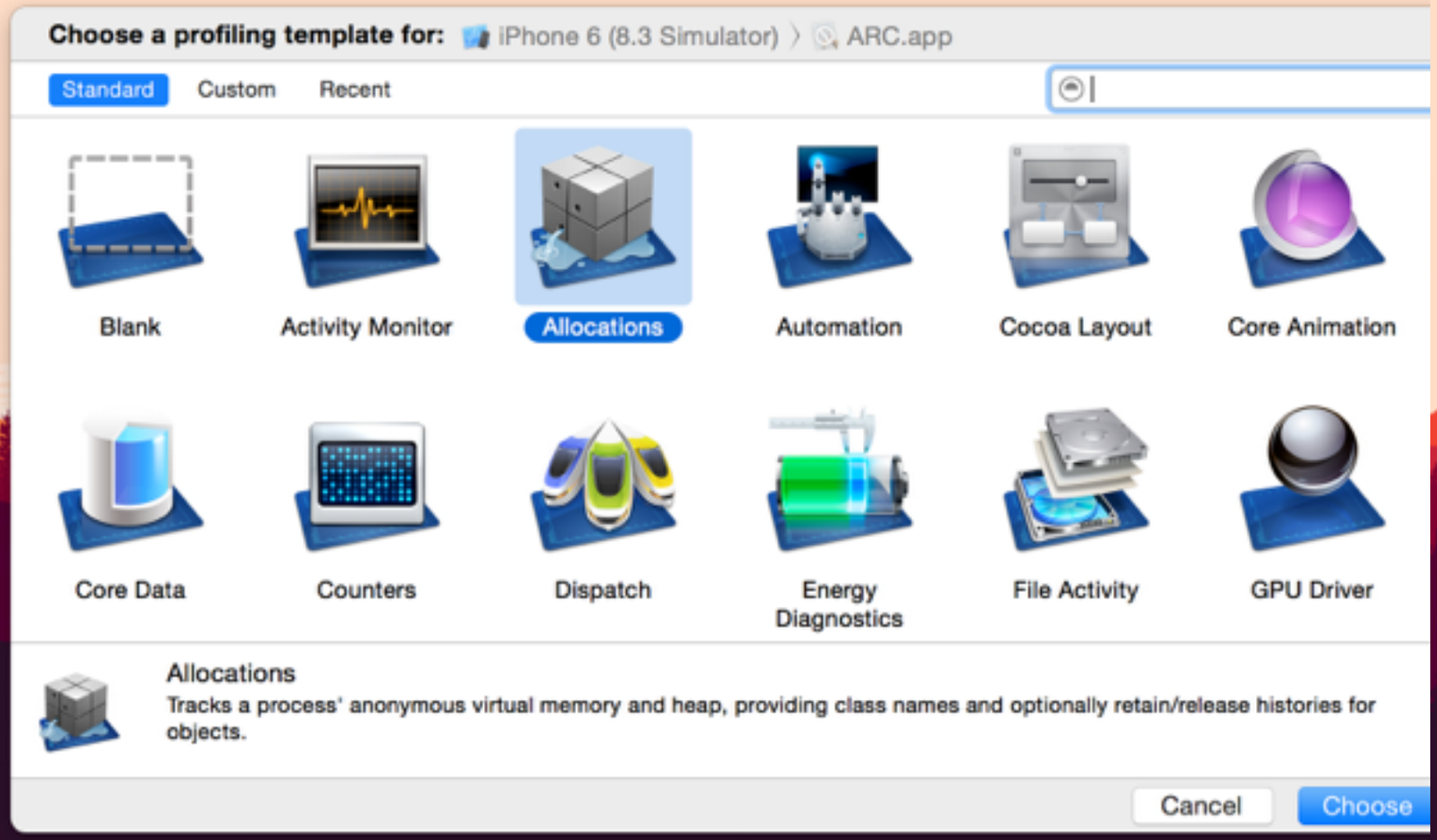
Choose a profiling template for: iPhone 6 (8.3 Simulator) 〉 ARC.app
Standard
Custom
Recent
Blank
Activity Monitor
Allocations
Automation
Cocoa Layout
Core Animation
Core Data
Counters
Dispatch
Energy Diagnostics
File Activity
GPU Driver
Allocations
Tracks a process' anonymous virtual memory and heap, providing class names and optionally retain/release histories for objects.
Cancel
Choose

Instruments File Edit View Instrument Window Help Qui 10 06 32 75%

Instruments5

iPhone 6 (8.3 Simulator) 〉 ARC.app | Run 0 of 0 | 00:00:00

Instruments

Allocations — Analyzes the memory life-cycle of process' allocated blocks; can record reference counting events.

VM Tracker — Tracks the virtual memory space of a process over time, identifying regions by tag and reporting usage statistics.

Allocations 〉 Statistics 〉 Allocation Summary | Instrument Detail

Graph	Category	Persistent By…	# Persistent	# Transient	Total Bytes	# Total	Transient/Total Bytes

Launch Configuration for All Allocations

- [x] Discard unrecorded data upon stop
- [ ] Discard events for freed memory
- [ ] Only track VM allocations

Launch Configuration for Heap Allocations

- [ ] Record reference counts
- [x] Identify virtual C++ objects
- [ ] Enable NSZombie detection

Track Display

Style: Current Bytes

Type: Overlay

Recorded Types

	Type String	Search	Action
☑	*	is Contai…	Record
☐	NS	is Prefix	Ignore
☐	CF	is Prefix	Ignore
☐	Malloc	is Prefix	Ignore

+ −

Rules are evaluated top-to-bottom; later rules override earlier ones.

Instruments File Edit View Instrument Window Help Qui 10:06:37 75%

Instruments5

iPhone 6 (8.3 Simulator) 〉 ARC.app | Run 1 of 1 | 00:00:03

Instruments

Allocations

VM Tracker

Allocations 〉 Statistics 〉 Allocation Summary | Instrument Detail

Graph	Category	Persistent By...	# Persistent	# Transient	Total Bytes	# Total	Transient/Total Bytes
☑	All Heap & Anonymous VM	19,75 MB	20.200	200.887	32,51 MB	221.087	
☐	All Heap Allocations	3,67 MB	20.185	200.874	15,70 MB	221.059	
☐	All Anonymous VM	16,08 MB	15	13	16,80 MB	28	
☐	VM: Dispatch continuations	16,00 MB	1	0	16,00 MB	1	
☐	Malloc 2,00 MB	2,00 MB	1	0	2,00 MB	1	
☐	CFString (store)	262,22 KB	1.576	808	398,83 KB	2.384	
☐	Malloc 32 Bytes	176,94 KB	5.662	46.178	1,58 MB	51.840	
☐	Malloc 64 Bytes	113,19 KB	1.811	55.678	3,51 MB	57.489	
☐	CFString (immutable)	84,45 KB	2.277	7.147	667,66 KB	9.424	
☐	CFBasicHash (value-store)	82,08 KB	181	286	127,75 KB	467	
☐	CFBasicHash (key-store)	78,33 KB	140	204	116,88 KB	344	
☐	Malloc 4,00 KB	76,00 KB	19	309	1,28 MB	328	
☐	Malloc 16 Bytes	74,19 KB	4.748	23.660	443,88 KB	28.408	
☐	Malloc 512 Bytes	60,50 KB	121	54	87,50 KB	175	
☐	Malloc 128 Bytes	58,25 KB	466	590	132,00 KB	1.056	
☐	NSPathStore2	47,02 KB	132	1.296	383,58 KB	1.428	
☐	VM: CoreAnimation	40,00 KB	10	0	40,00 KB	10	
☐	Malloc 2,00 KB	38,00 KB	19	40	118,00 KB	59	
☐	Malloc 8,00 KB	32,00 KB	4	1	40,00 KB	5	
☐	Malloc 256 Bytes	30,25 KB	121	253	93,50 KB	374	
☐	Malloc 2,50 KB	25,00 KB	10	9	47,50 KB	19	
☐	Malloc 1,00 KB	24,00 KB	24	23	47,00 KB	47	
☐	Malloc 48 Bytes	22,69 KB	484	44.553	2,06 MB	45.037	
☐	VM: Allocation 20,00 KB	20,00 KB	1	0	20,00 KB	1	

Generation Analysis

Mark Generation

Allocation Lifespan

- All Allocations
- Created & Persistent
- Created & Destroyed

Allocation Type

- All Heap & Anonymous VM
- All Heap Allocations
- All VM Regions

Call Tree

- Separate by Category
- Separate by Thread
- Invert Call Tree
- Hide System Libraries
- Flatten Recursion

Call Tree Constraints

Count 0 ∞

Bytes -∞ ∞

Data Mining

Instruments File Edit View Instrument Window Help Qui 10:06:45 75%

Instruments5

iPhone 6 (8.3 Simulator) 〉 ARC.app | Run 1 of 1 | 00:00:11

Instruments

Allocations

VM Tracker

Allocations 〉 Statistics 〉 Allocation Summary | pessoa

Graph	Category	Persistent By...	# Persistent	# Transient	Total Bytes	# Total	Transient/Total Bytes
☐	ARC.Pessoa	32 Bytes	1	0	32 Bytes	1	

Generation Analysis

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Allocation Lifespan

- ○ All Allocations
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Call Tree Constraints

- ☐ Count 0 ∞
- ☐ Bytes -∞ ∞

Data Mining

Instruments File Edit View Instrument Window Help
Qui 10:06:45 75%
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iPhone 6 (8.3 Simulator) ARC.app
Run 1 of 1 00:00:11
Instruments
Allocations
VM Tracker
Allocations Statistics Allocation Summary
pessoa
Graph Category Persistent By... # Persistent # Transient Total Bytes # Total Transient/Total Bytes
ARC.Pessoa 32 Bytes 1 0 32 Bytes 1
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Instruments File Edit View Instrument Window Help Qui 10:06:45 75%

Instruments5

iPhone 6 (8.3 Simulator) 〉 ARC.app | Run 1 of 1 | 00:00:11

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Data Mining

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Data Mining

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Data Mining

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Instruments5

iPhone 6 (8.3 Simulator) 〉 ARC.app | Run 1 of 1 | 00:00:18

Instruments

Allocations

VM Tracker

Allocations 〉 Statistics 〉 Allocation Summary | pessoa

Graph	Category	Persistent By...	# Persistent	# Transient	Total Bytes	# Total	Transient/Total Bytes
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- ☐ Bytes -∞ ∞

Data Mining

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iPhone 6 (8.3 Simulator) 〉 ARC.app | Run 1 of 1 | 00:00:18

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iPhone 6 (8.3 Simulator) 〉 ARC.app | Run 1 of 1 | 00:00:18

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- ☐ Bytes -∞ ∞

Data Mining

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iPhone 6 (8.3 Simulator) 〉 ARC.app | Run 1 of 1 | 00:00:32

Instruments

Allocations

VM Tracker

Allocations 〉 Statistics 〉 Allocation Summary 〉 ARC.Pessoa | pessoa

#	Address	Category	Timestamp	Live	Size	Responsible Library	Responsible Caller
0	0x7fc3d375...	ARC.Pessoa	00:01.025.762	•	32 Bytes	libswiftCore.dylib	swift_slowAlloc

Generation Analysis

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Call Tree Constraints

Count 0 ∞

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iPhone 6 (8.3 Simulator) 〉 ARC.app | Run 1 of 1 | 00:00:32

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Allocations 〉 Statistics 〉 Allocation Summary 〉 ARC.Pessoa | pessoa

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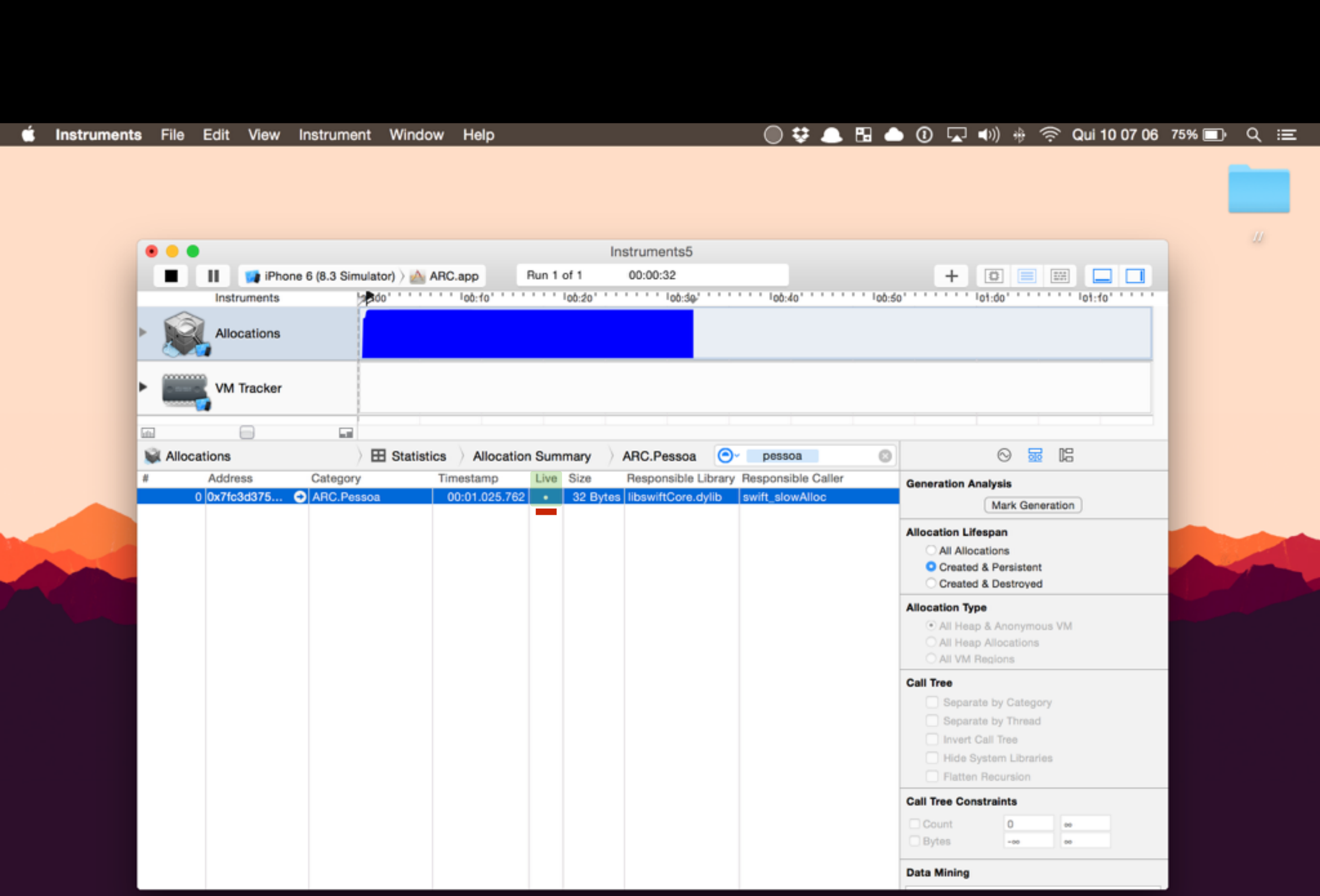
Count 0 ∞

Bytes -∞ ∞

Data Mining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Call Tree Constraints
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Data Mining

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iPhone 6 (8.3 Simulator) 〉 ARC.app | Run 1 of 1 | 00:00:26

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Allocations

VM Tracker

Allocations 〉 Statistics 〉 Allocation Summary 〉 ARC.Pessoa | pessoa

#	Address	Category	Timestamp	Live	Size	Responsible Library	Responsible Caller
0	0x7fc3d375...	ARC.Pessoa	00:01.025.762	•	32 Bytes	libswiftCore.dylib	swift_slowAlloc

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Call Tree Constraints

Count 0 ∞

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Data Mining

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iPhone 6 (8.3 Simulator) 〉 ARC.app

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Instruments

Allocations

VM Tracker

Allocations 〉 Statistics 〉 Allocation Summary 〉 ARC.Pessoa

pessoa

#	Address	Category	Timestamp	Live	Size	Responsible Library	Responsible Caller
0	0x7fc3d375...	ARC.Pessoa	00:01.025.762	•	32 Bytes	libswiftCore.dylib	swift_slowAlloc

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Count 0 ∞

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Data Mining

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Run 1 of 1
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Allocations
VM Tracker
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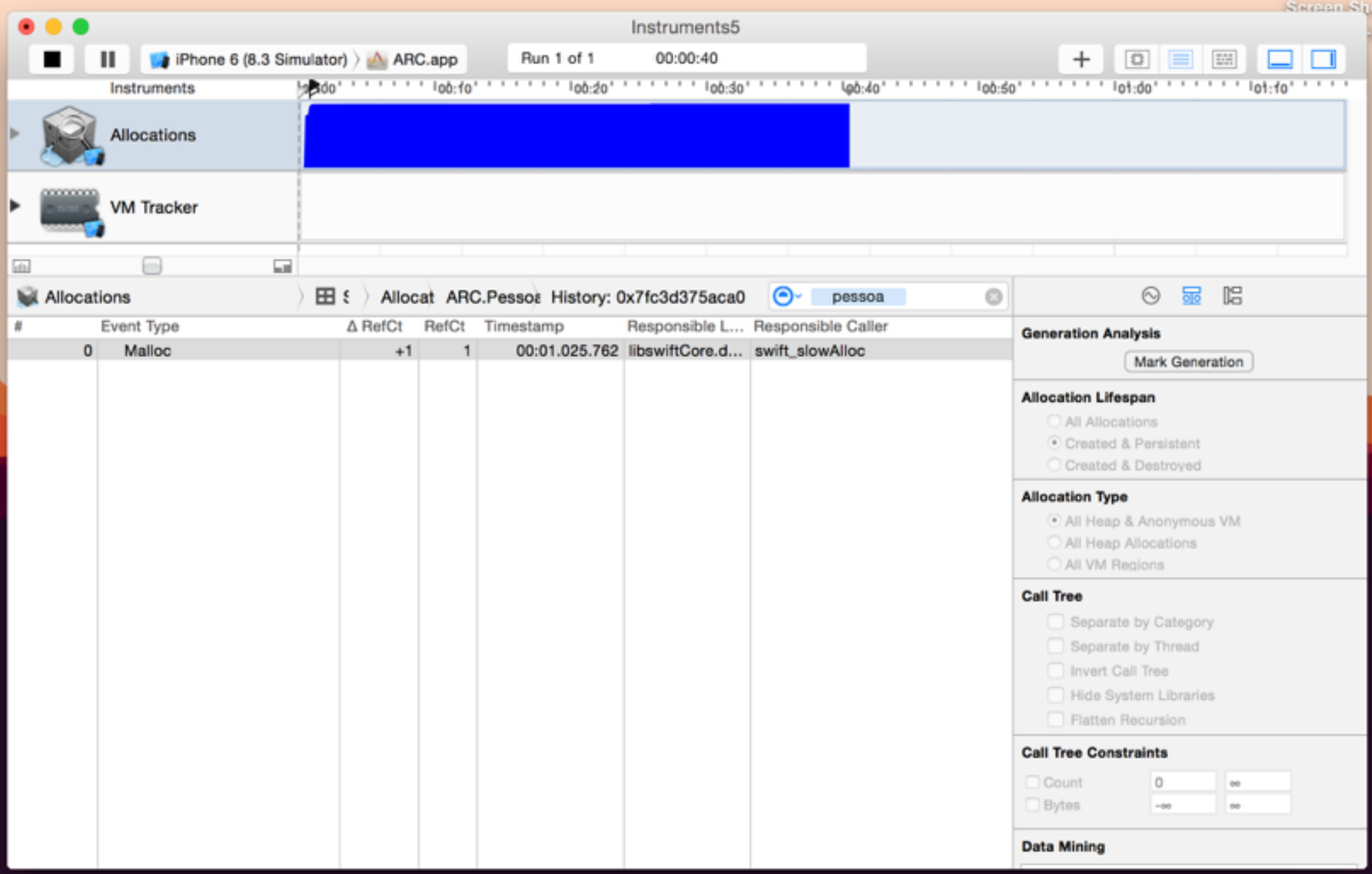

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Instruments5

iPhone 6 (8.3 Simulator) 〉 ARC.app

Run 1 of 1 00:00:40

Instruments

Allocations

VM Tracker

Allocations 〉 Allocat ARC.Pessoa History: 0x7fc3d375aca0

pessoa

#	Event Type	Δ RefCt	RefCt	Timestamp	Responsible L...	Responsible Caller
0	Malloc	+1	1	00:01.025.762	libswiftCore.d...	swift_slowAlloc

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Call Tree Constraints

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Data Mining

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Instruments

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Data Mining

Referências:

- https://developer.apple.com/library/ios/documentation/Swift/Conceptual/Swift_Programming_Language/AutomaticReferenceCounting.html
- http://www.ibm.com/developerworks/library/mo-ios-memory/

Thanks ;)

github.com/txaidw

twitter.com/txaidw