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瀑布IM

逆向工程
从 OBJ-C 到 SWIFT

什么是逆向工程?

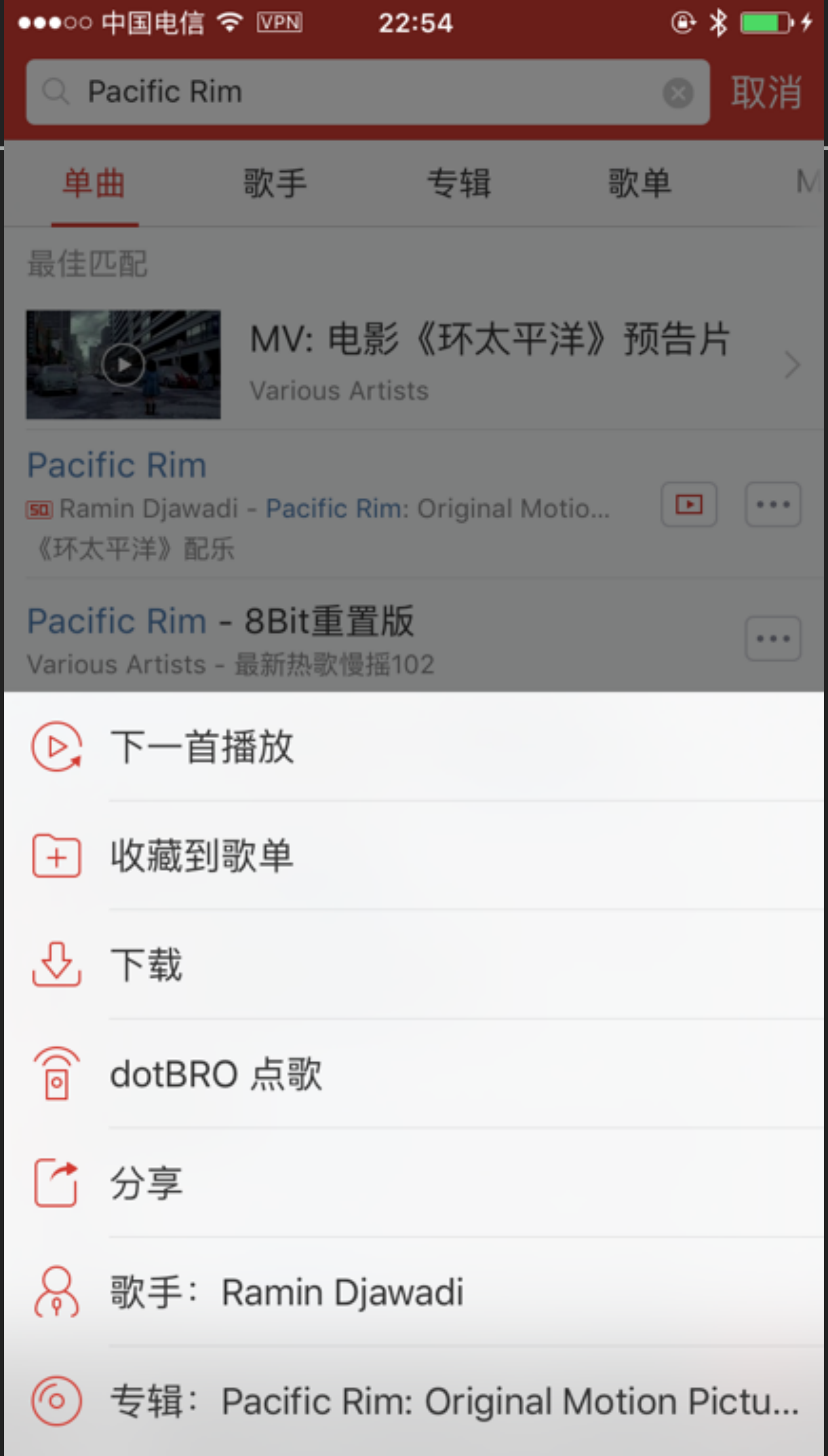
一种技术过程，即对一项目标产品进行逆向分析及研究，从而演绎并得出该产品的处理流程、组织结构、功能性能规格等设计要素，以制作出功能相近，但又不完全一样的产品。

— 维基百科

逆向工程的目标

- 学习
  - 设计
  - 实现
  - 算法
- 除错
- 扩展
  - 插件

APP 插件



●●●○○ 中国电信 VPN 22:54

Pacific Rim 取消

单曲 歌手 专辑 歌单 M

最佳匹配

MV: 电影《环太平洋》预告片
Various Artists

Pacific Rim
SQ Ramin Djawadi - Pacific Rim: Original Motio...
《环太平洋》配乐

Pacific Rim - 8Bit重置版
Various Artists - 最新热歌慢摇102

下一首播放

收藏到歌单

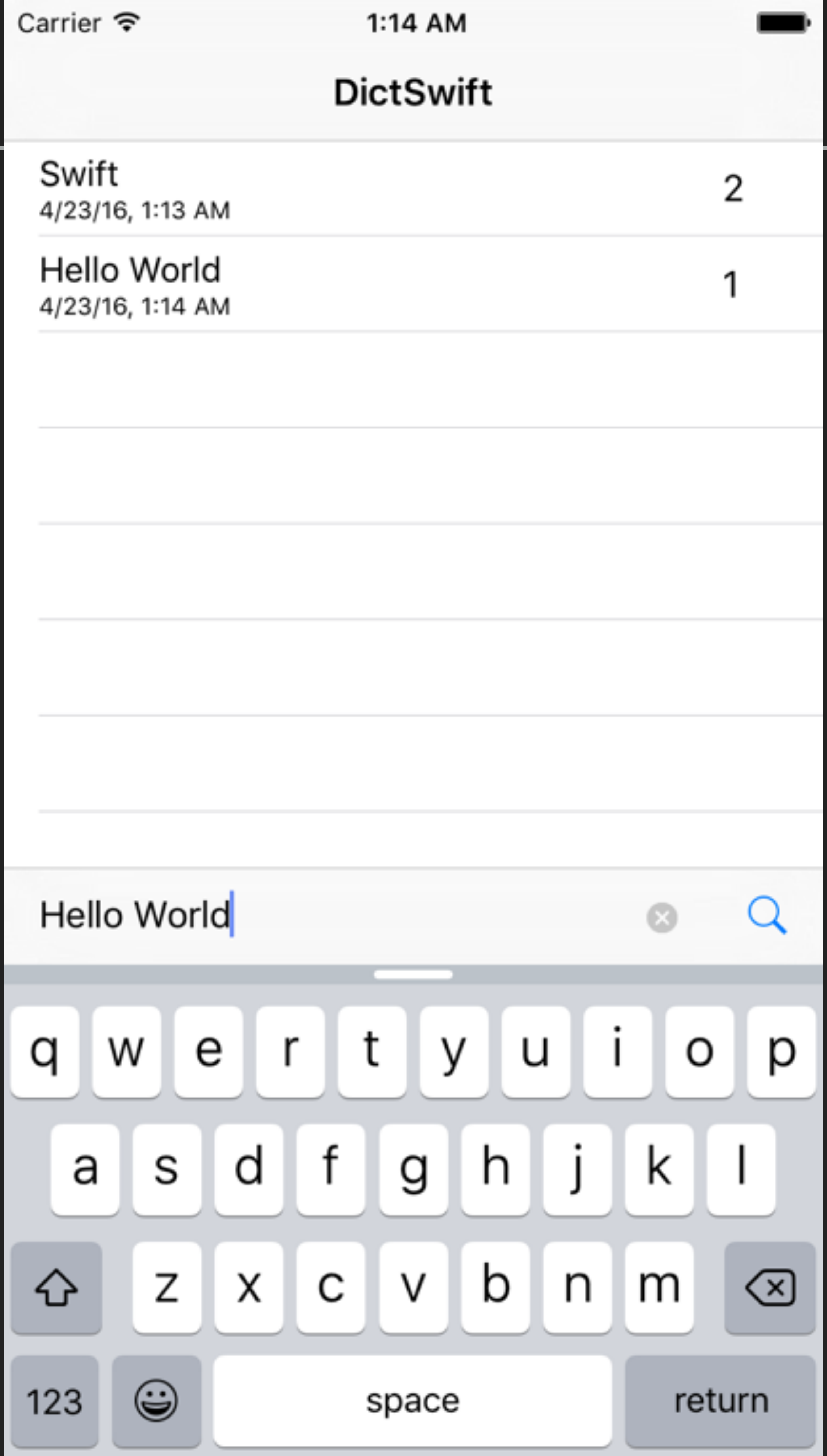
下载

dotBRO 点歌

分享

歌手： Ramin Djawadi

专辑： Pacific Rim: Original Motion Pictu...

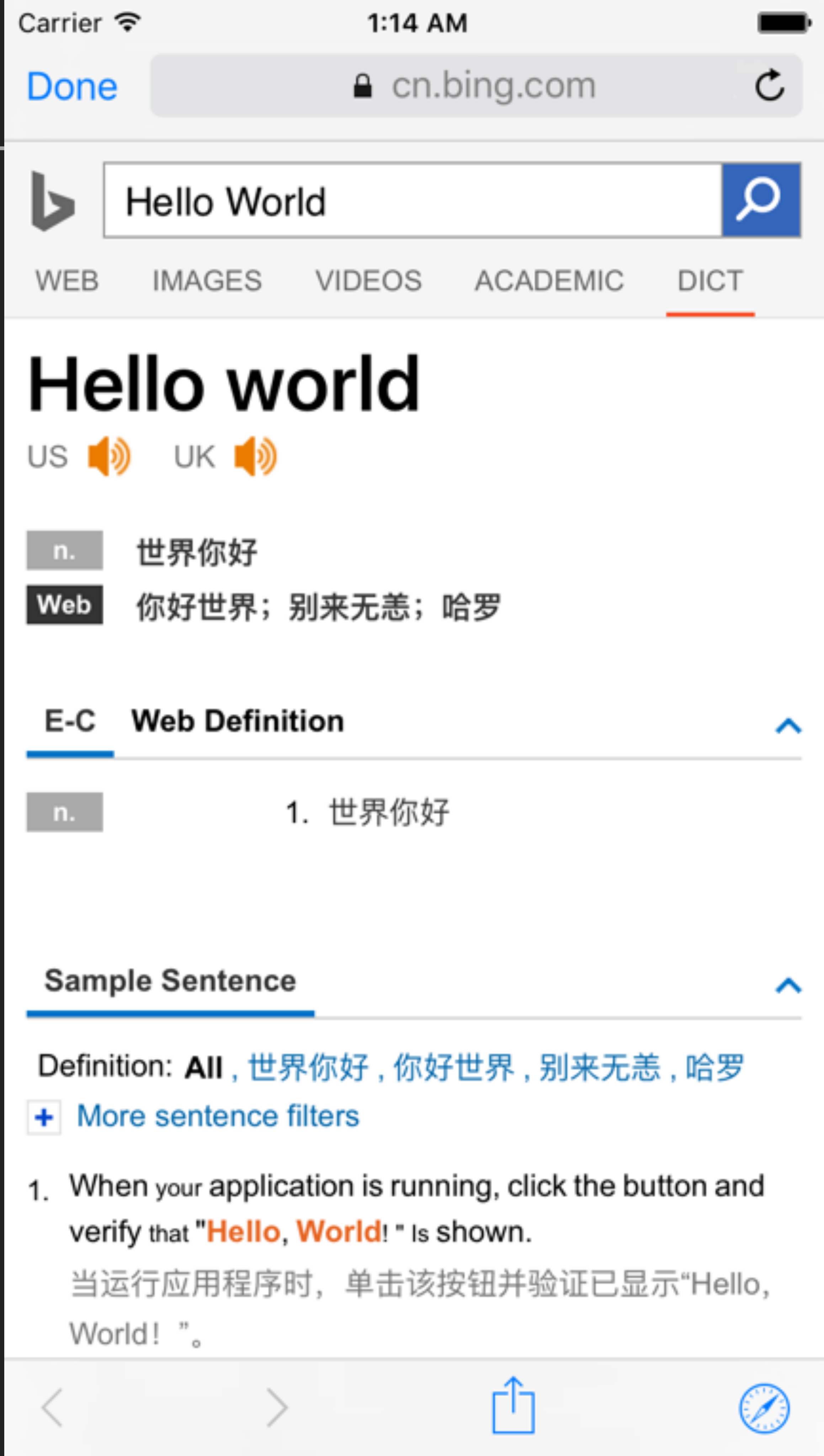


DictSwift

Swift 2
4/23/16, 1:13 AM

Hello World 1
4/23/16, 1:14 AM

Hello World



Hello World

Hello world

US UK

n. 世界你好

Web 你好世界；别来无恙；哈罗

E-C Web Definition

n. 1. 世界你好

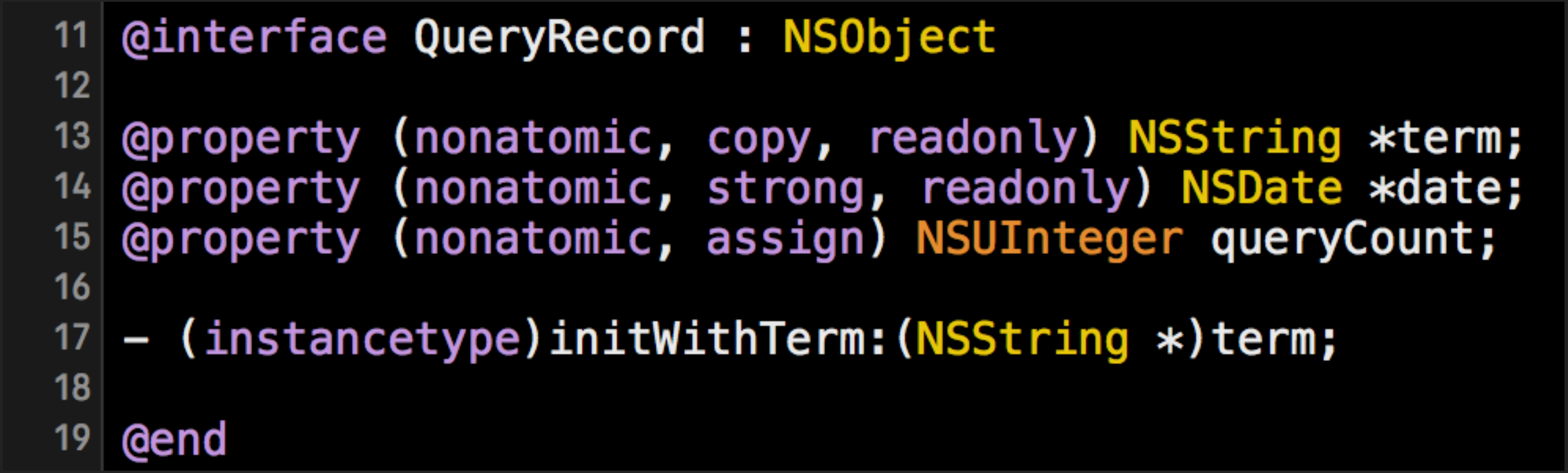
Sample Sentence

Definition: All , 世界你好 , 你好世界 , 别来无恙 , 哈罗

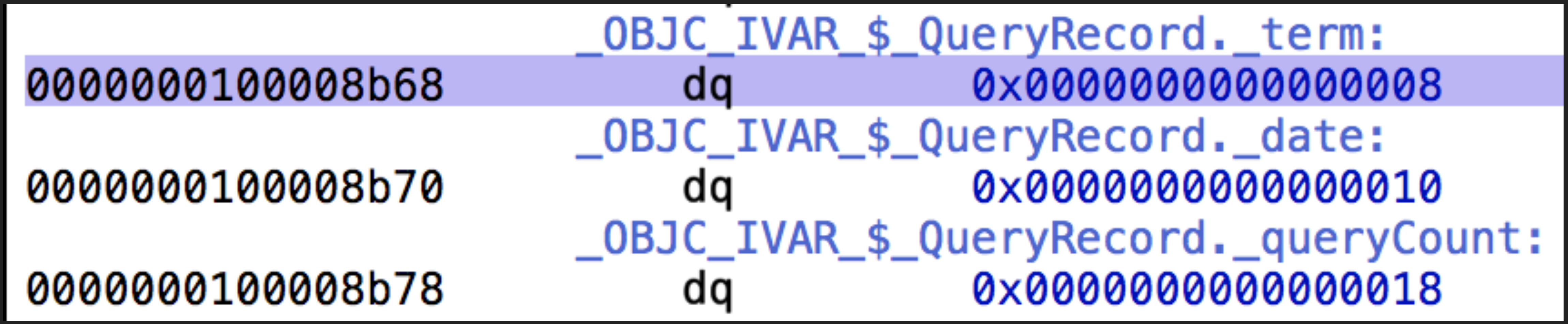
+ More sentence filters

1. When your application is running, click the button and verify that "Hello, World! " Is shown.
当运行应用程序时，单击该按钮并验证已显示“Hello, World！ ”。

DEMO

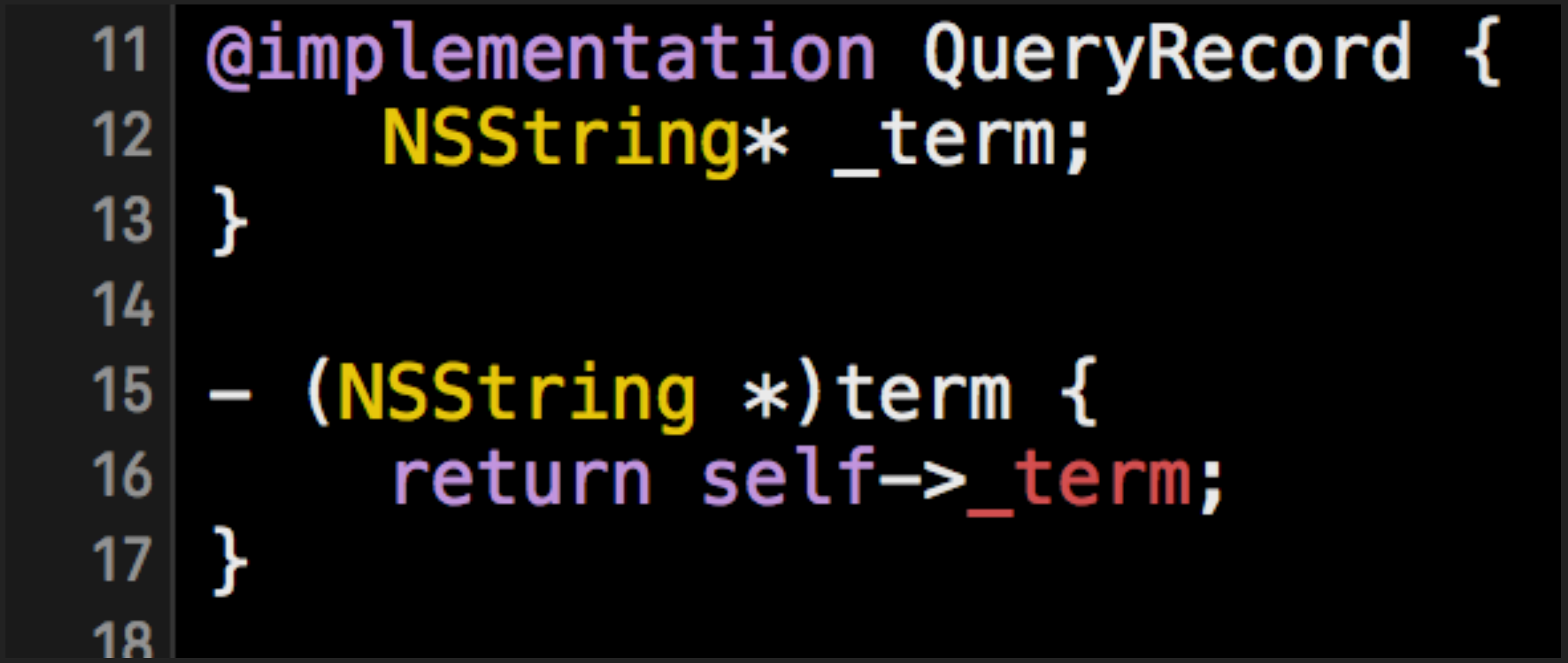


```
@interface QueryRecord : NSObject

@property (nonatomic, copy, readonly) NSString *term;
@property (nonatomic, strong, readonly) NSDate *date;
@property (nonatomic, assign) NSUInteger queryCount;

- (instancetype)initWithTerm:(NSString *)term;

@end
```

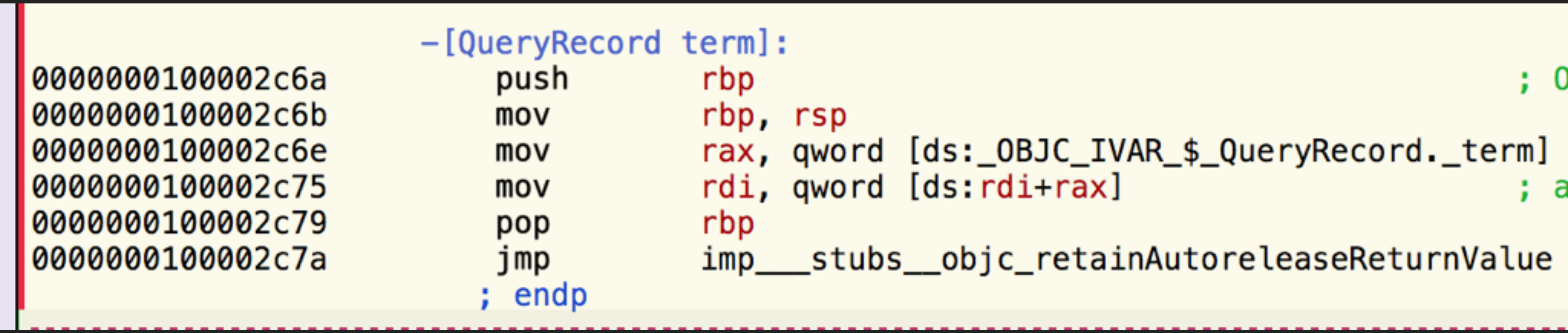


```
                    _OBJC_IVAR_$_QueryRecord._term:
000000100008b68         dq          0x0000000000000008
                    _OBJC_IVAR_$_QueryRecord._date:
000000100008b70         dq          0x0000000000000010
                    _OBJC_IVAR_$_QueryRecord._queryCount:
000000100008b78         dq          0x0000000000000018
```

DEMO: NON-FRAGILE LAYOUT



```objc
@implementation QueryRecord {
    NSString* _term;
}

- (NSString *)term {
    return self->_term;
}
```



```
                    -[QueryRecord term]:
0000000100002c6a        push       rbp                                                        ; 0
0000000100002c6b        mov        rbp, rsp
0000000100002c6e        mov        rax, qword [ds:_OBJC_IVAR_$_QueryRecord._term]
0000000100002c75        mov        rdi, qword [ds:rdi+rax]                                    ; a
0000000100002c79        pop        rbp
0000000100002c7a        jmp        imp___stubs__objc_retainAutoreleaseReturnValue
                        ; endp
```

X86_64 调用约定

- arg1: $rdi
- arg2: $rsi
- arg3: $rdx
- arg4: $rcx
- arg5: $r8
- arg6: $r9

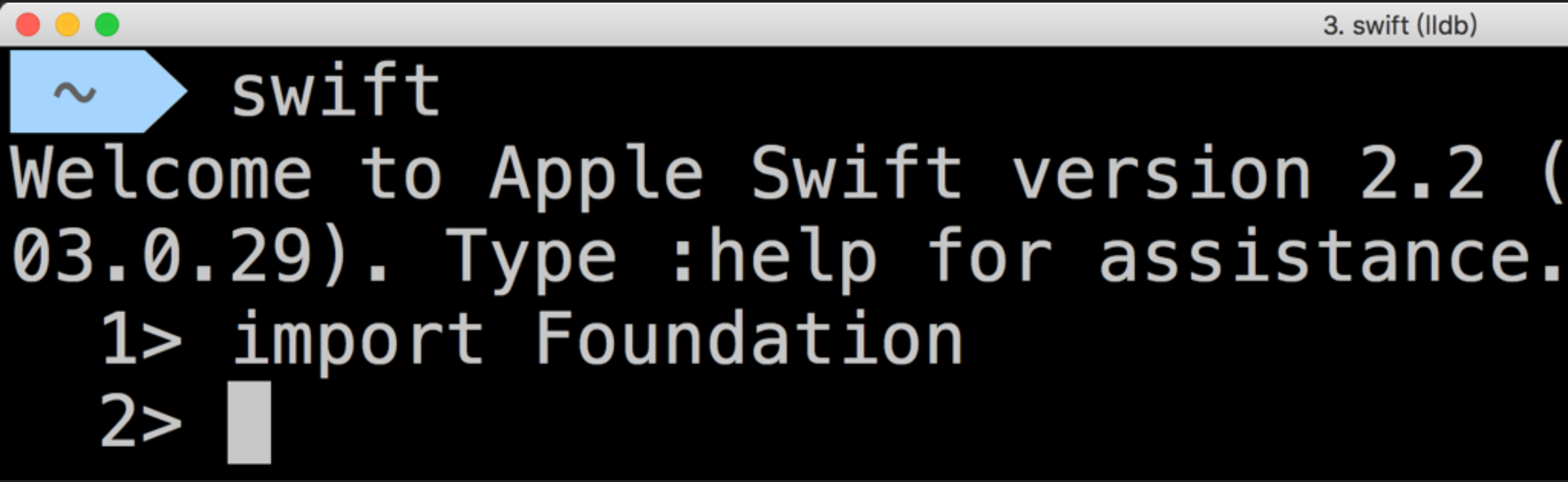
- ret1: $rax
- ret2: $rdx
- indirect: $rax (== $rdi)

OBJECTIVE-C 调用约定

- arg1: $rdi -> self
- arg2: $rsi -> _cmd
- arg3: $rdx
- arg4: $rcx
- arg5: $r8
- arg6: $r9

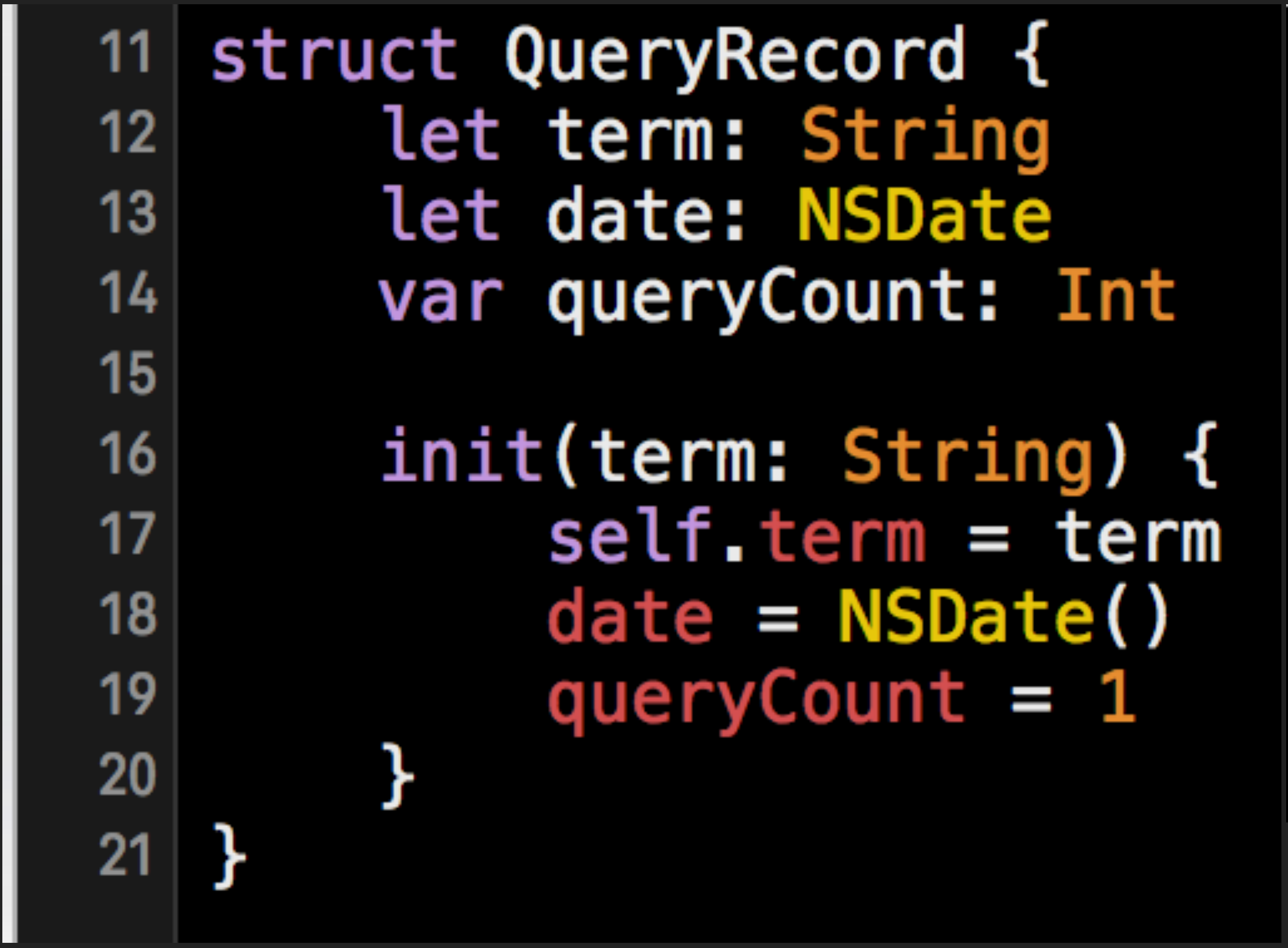
- ret: $rax

SWIFT REPL

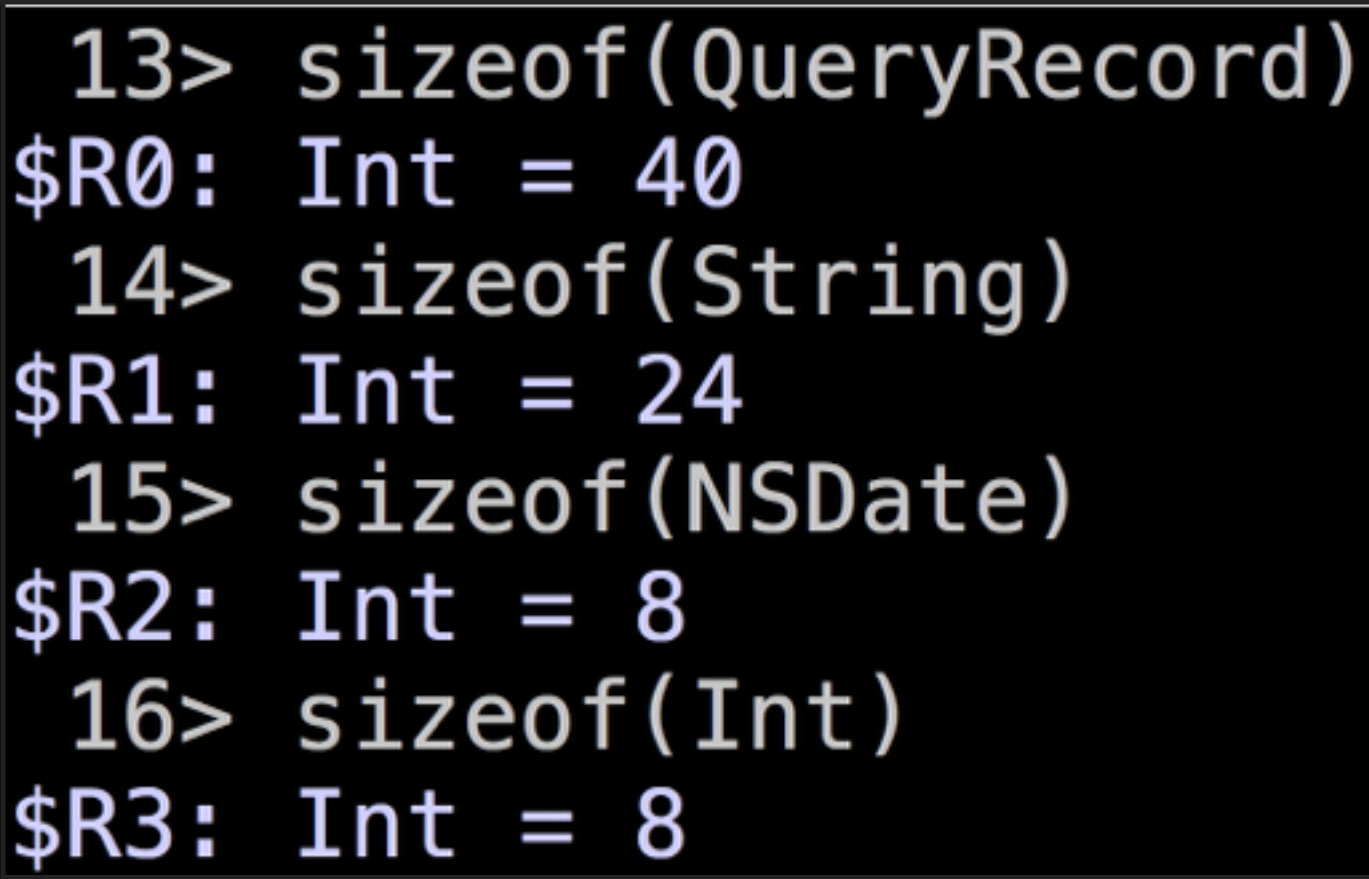


```
 ~   swift
Welcome to Apple Swift version 2.2 (
03.0.29). Type :help for assistance.
  1> import Foundation
  2> 
```

DEMO: STRUCT

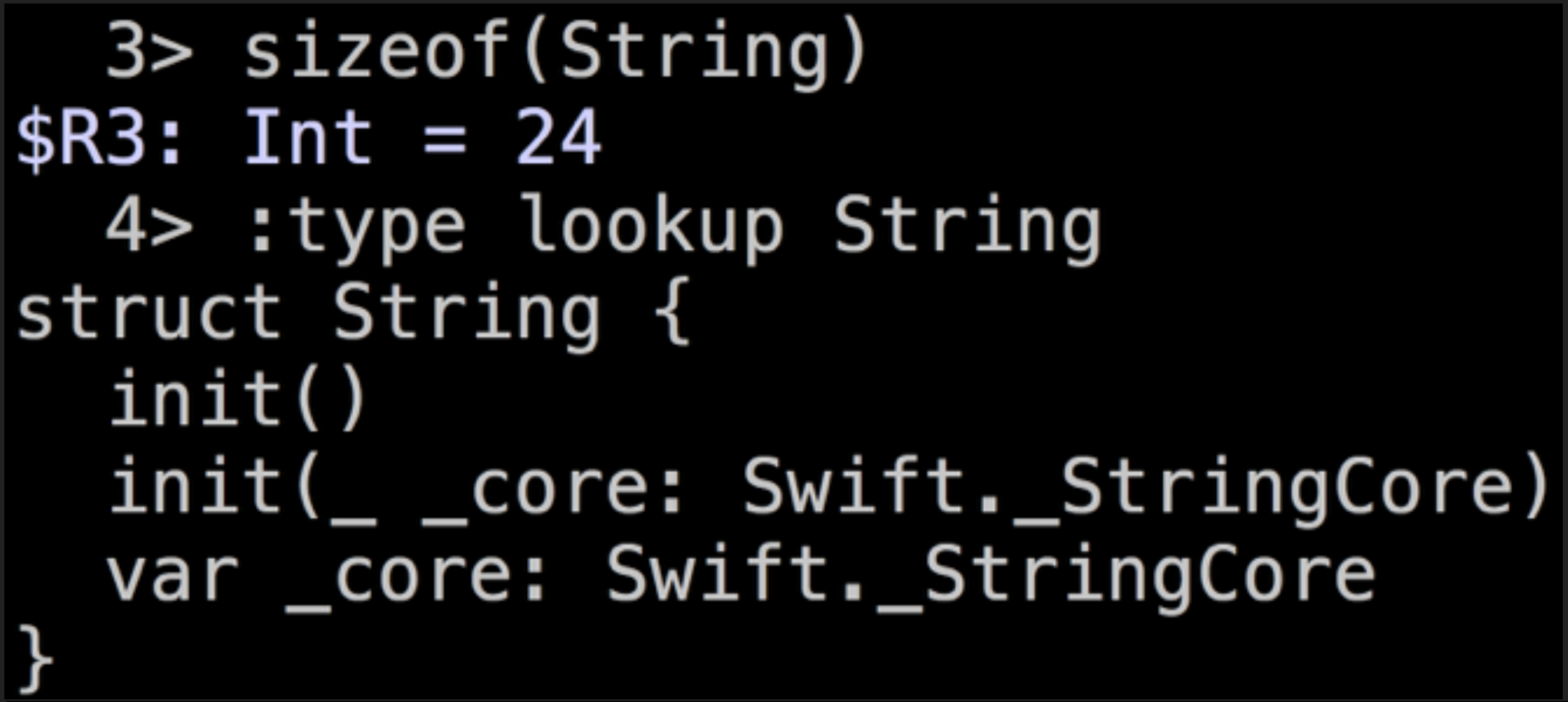


```swift
struct QueryRecord {
    let term: String
    let date: NSDate
    var queryCount: Int

    init(term: String) {
        self.term = term
        date = NSDate()
        queryCount = 1
    }
}
```

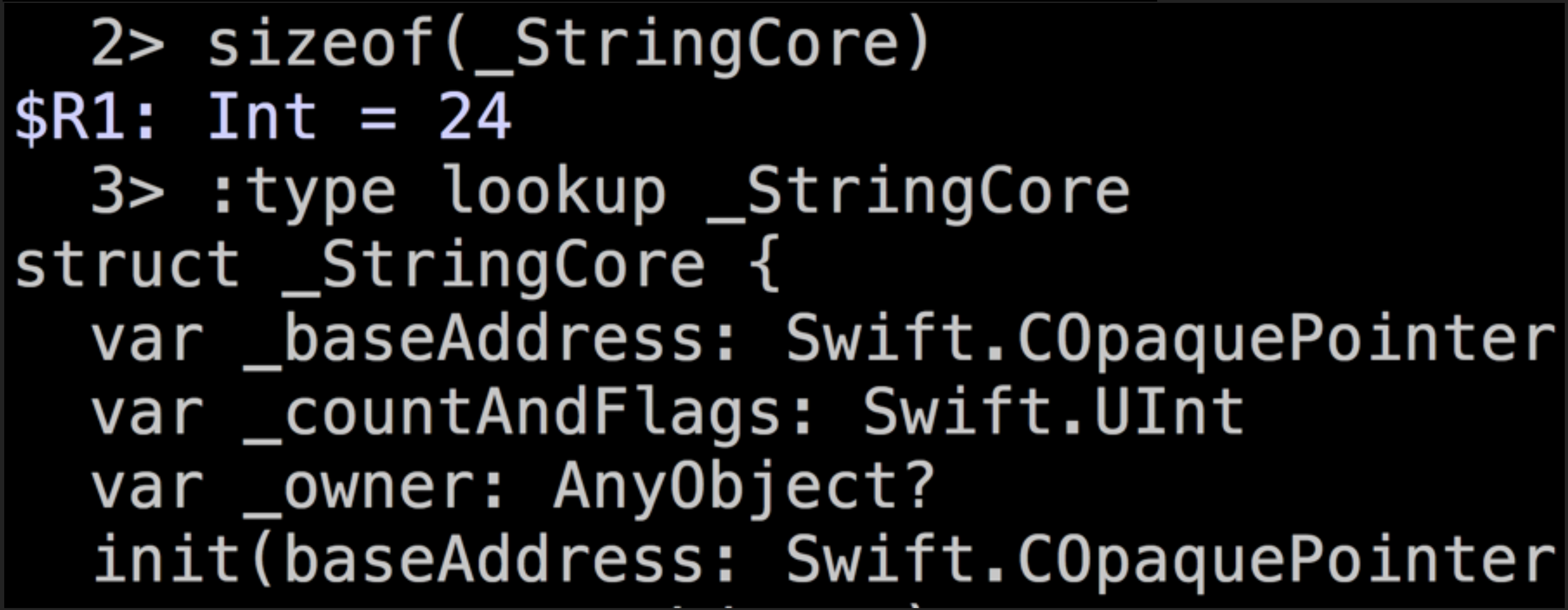


```
 13> sizeof(QueryRecord)
$R0: Int = 40
 14> sizeof(String)
$R1: Int = 24
 15> sizeof(NSDate)
$R2: Int = 8
 16> sizeof(Int)
$R3: Int = 8
```

DEMO

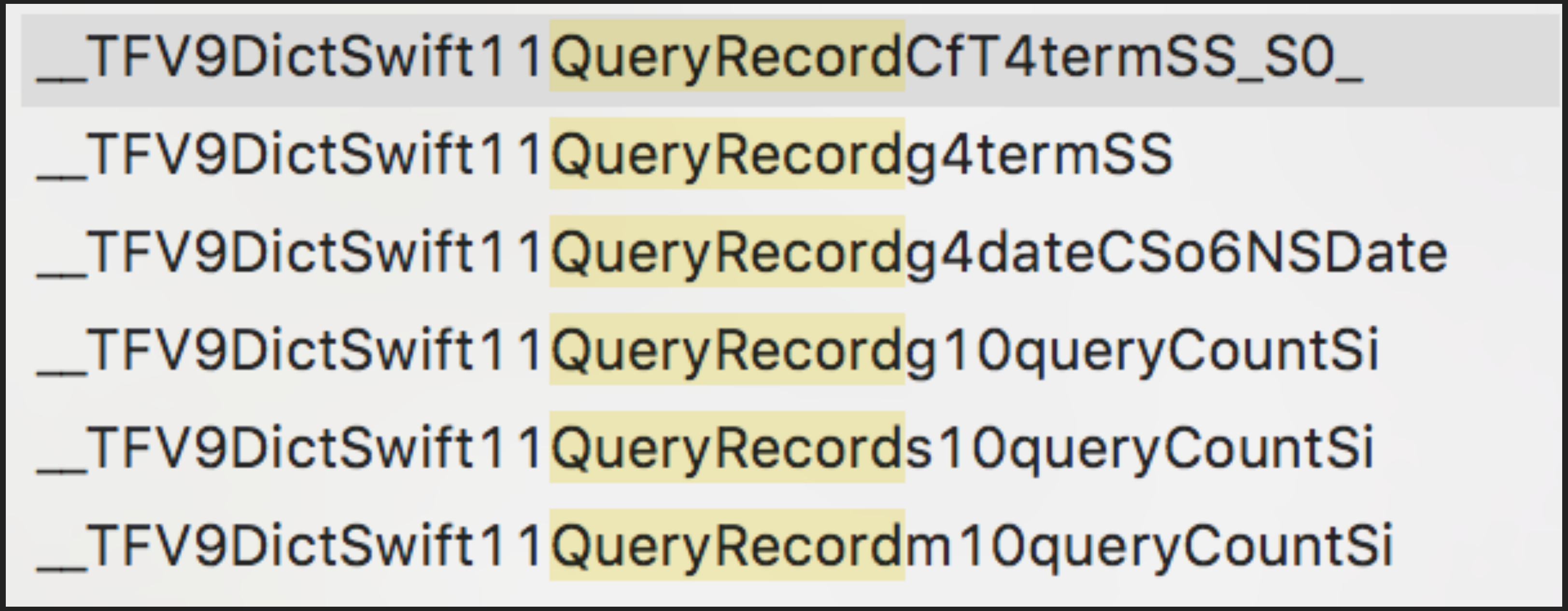


```
  3> sizeof(String)
$R3: Int = 24
  4> :type lookup String
struct String {
  init()
  init(_ _core: Swift._StringCore)
  var _core: Swift._StringCore
}
```



```
  2> sizeof(_StringCore)
$R1: Int = 24
  3> :type lookup _StringCore
struct _StringCore {
  var _baseAddress: Swift.COpaquePointer
  var _countAndFlags: Swift.UInt
  var _owner: AnyObject?
  init(baseAddress: Swift.COpaquePointer
```

SWIFT-DEMANGLE

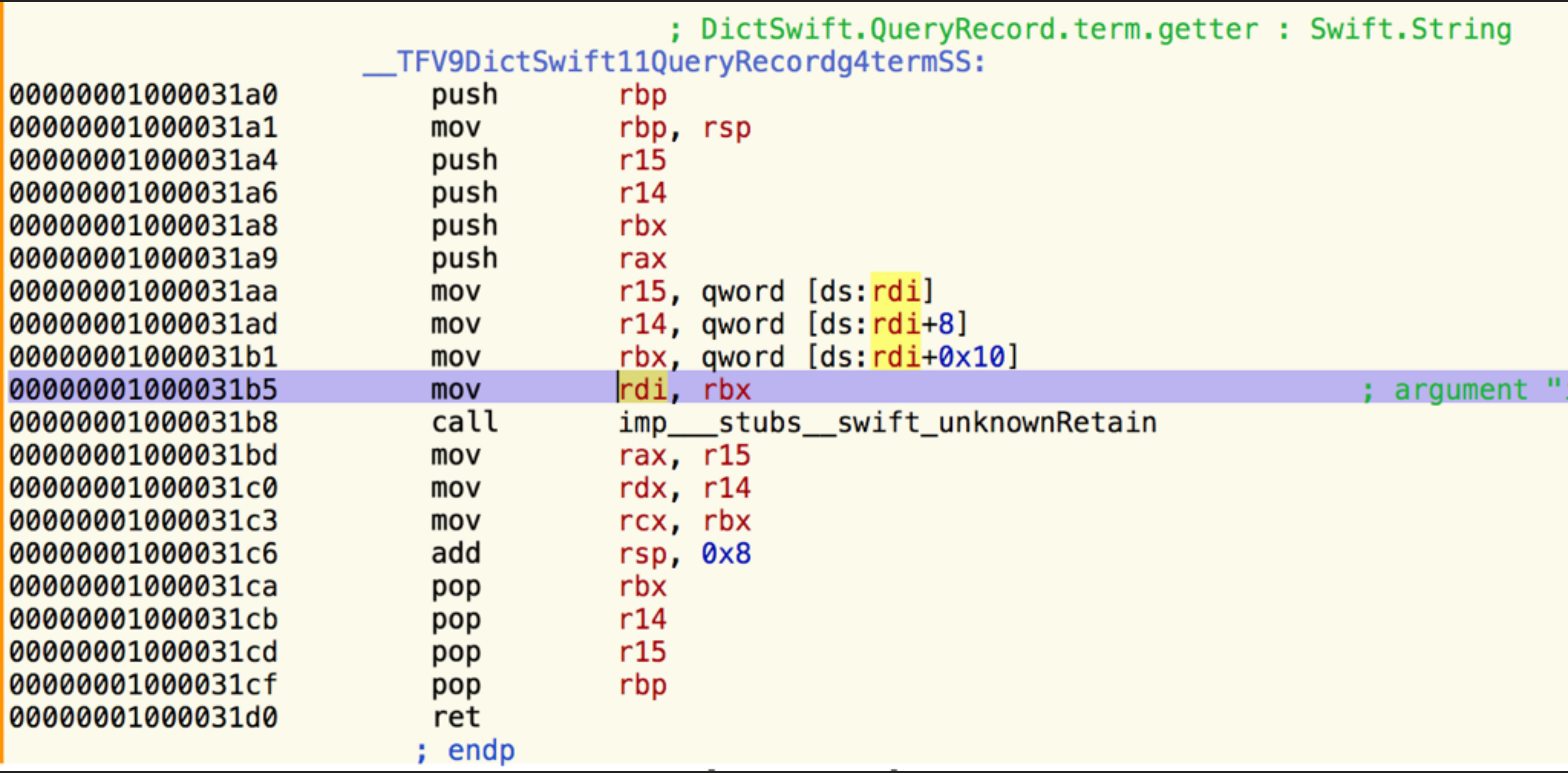


```
__TFV9DictSwift11QueryRecordCfT4termSS_S0_
__TFV9DictSwift11QueryRecordg4termSS
__TFV9DictSwift11QueryRecordg4dateCSo6NSDate
__TFV9DictSwift11QueryRecordg10queryCountSi
__TFV9DictSwift11QueryRecords10queryCountSi
__TFV9DictSwift11QueryRecordm10queryCountSi
```

```
$ xcrun swift-demangle
_TFV9DictSwift11QueryRecordg4termSS
```

```
_TFV9DictSwift11QueryRecordg4termSS --->
DictSwift.QueryRecord.term.getter : Swift.String
```

DEMO



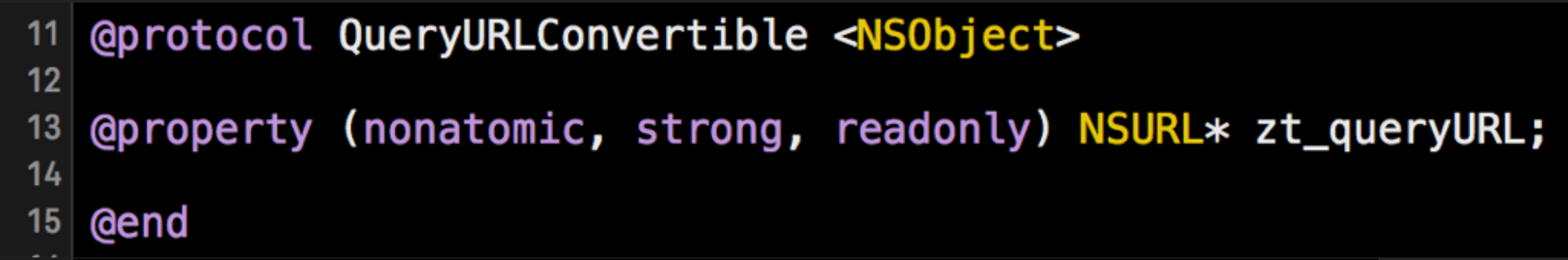
```
                                        ; DictSwift.QueryRecord.term.getter : Swift.String
                     __TFV9DictSwift11QueryRecordg4termSS:
00000001000031a0         push       rbp
00000001000031a1         mov        rbp, rsp
00000001000031a4         push       r15
00000001000031a6         push       r14
00000001000031a8         push       rbx
00000001000031a9         push       rax
00000001000031aa         mov        r15, qword [ds:rdi]
00000001000031ad         mov        r14, qword [ds:rdi+8]
00000001000031b1         mov        rbx, qword [ds:rdi+0x10]
00000001000031b5         mov        rdi, rbx                                     ; argument "
00000001000031b8         call       imp___stubs__swift_unknownRetain
00000001000031bd         mov        rax, r15
00000001000031c0         mov        rdx, r14
00000001000031c3         mov        rcx, rbx
00000001000031c6         add        rsp, 0x8
00000001000031ca         pop        rbx
00000001000031cb         pop        r14
00000001000031cd         pop        r15
00000001000031cf         pop        rbp
00000001000031d0         ret
                         ; endp
```

SWIFT NATIVE 调用约定

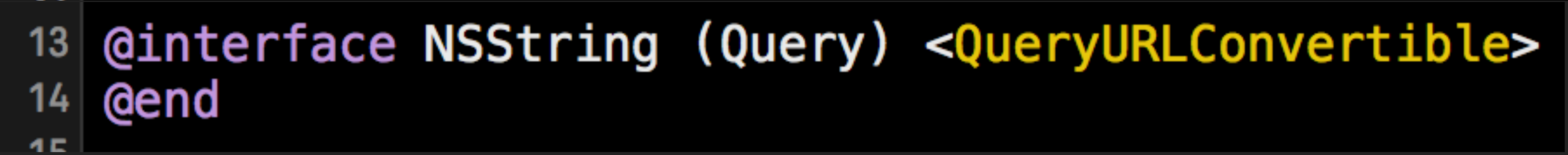
- arg1: $rdi
- arg2: $rsi
- arg3: $rdx
- arg4: $rcx
- arg5: $r8
- arg6: $r9

- ret1: $rax
- ret2: $rdx
- ret3: $rcx
- indirect: $rax (== $rdi)

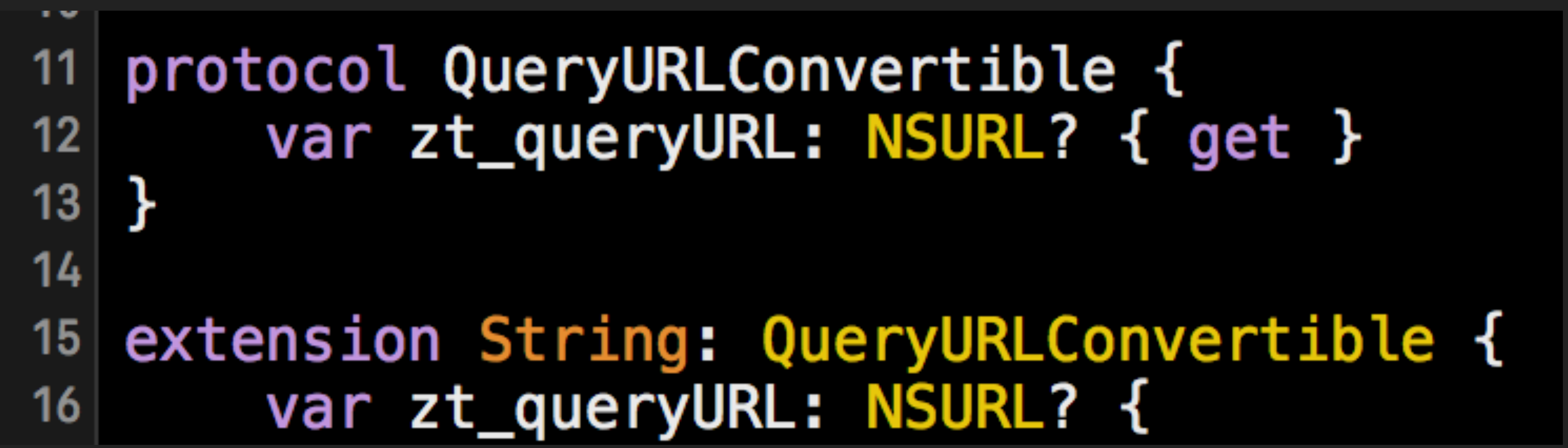
DEMO



```
@protocol QueryURLConvertible <NSObject>

@property (nonatomic, strong, readonly) NSURL* zt_queryURL;

@end
```

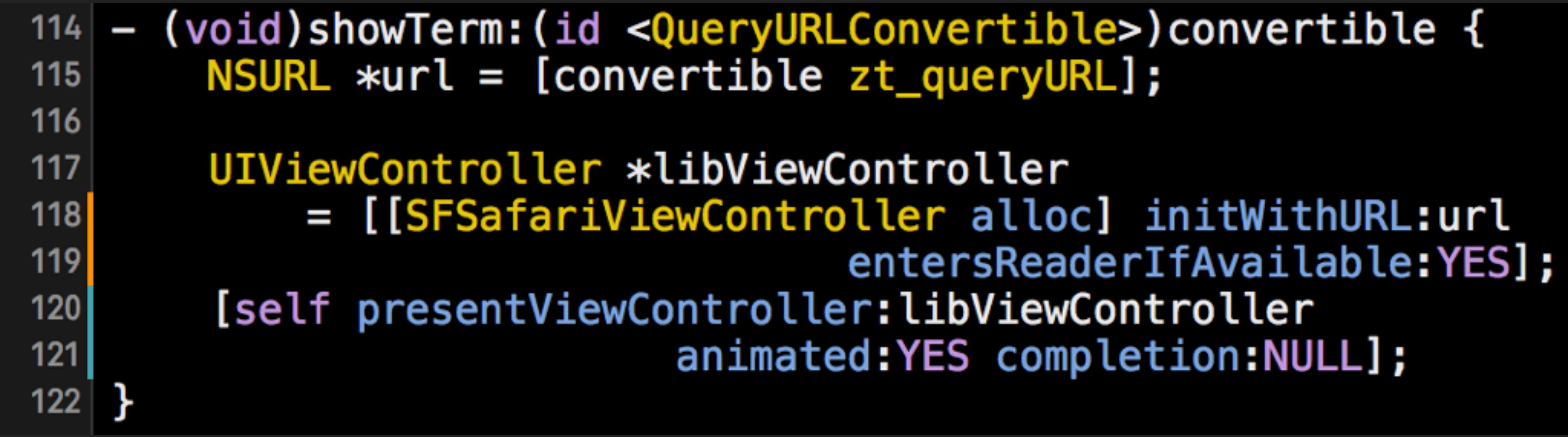


```
@interface NSString (Query) <QueryURLConvertible>
@end
```

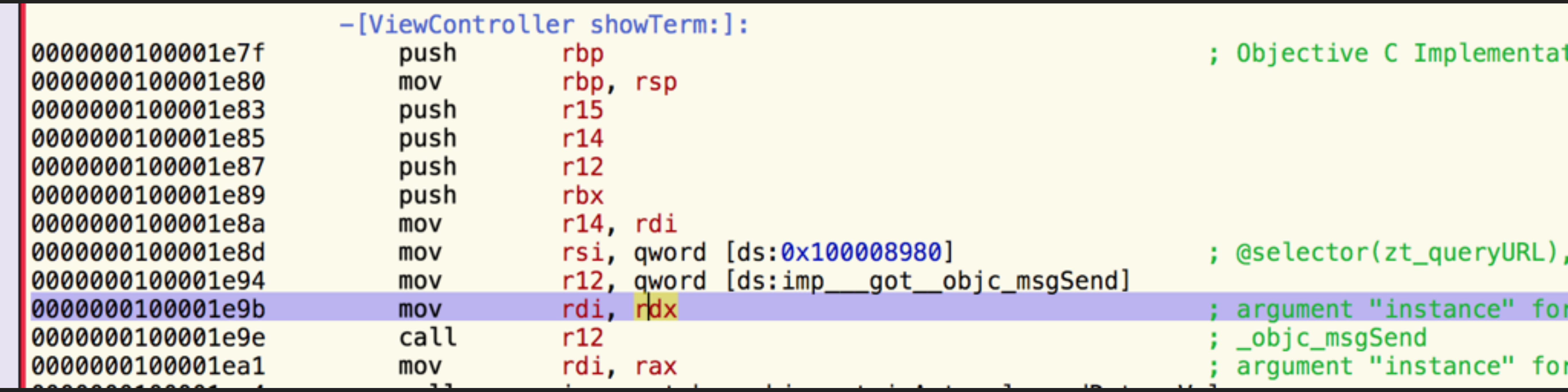


```
protocol QueryURLConvertible {
    var zt_queryURL: NSURL? { get }
}

extension String: QueryURLConvertible {
    var zt_queryURL: NSURL? {
```

DEMO

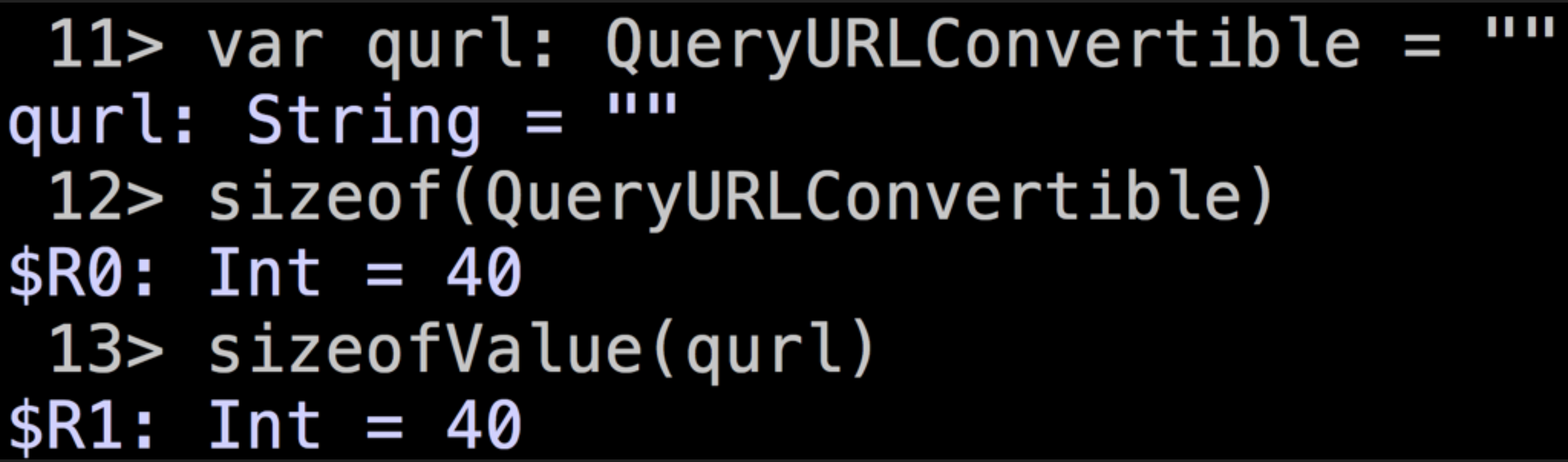


```
- (void)showTerm:(id <QueryURLConvertible>)convertible {
    NSURL *url = [convertible zt_queryURL];

    UIViewController *libViewController
        = [[SFSafariViewController alloc] initWithURL:url
                              entersReaderIfAvailable:YES];
    [self presentViewController:libViewController
                       animated:YES completion:NULL];
}
```



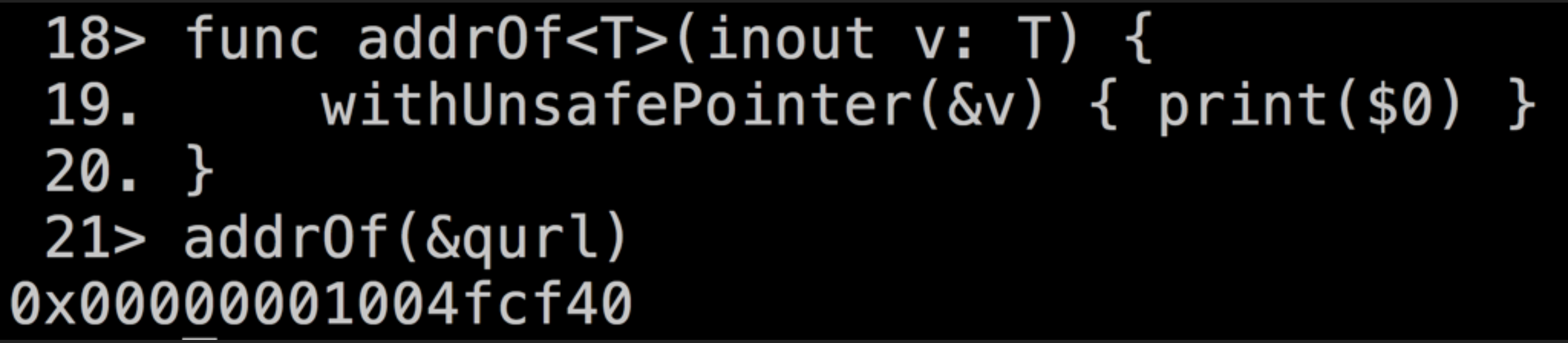
```
                    -[ViewController showTerm:]:
0000000100001e7f        push       rbp                                    ; Objective C Implementat
0000000100001e80        mov        rbp, rsp
0000000100001e83        push       r15
0000000100001e85        push       r14
0000000100001e87        push       r12
0000000100001e89        push       rbx
0000000100001e8a        mov        r14, rdi
0000000100001e8d        mov        rsi, qword [ds:0x100008980]            ; @selector(zt_queryURL),
0000000100001e94        mov        r12, qword [ds:imp___got__objc_msgSend]
0000000100001e9b        mov        rdi, rdx                               ; argument "instance" for
0000000100001e9e        call       r12                                    ; _objc_msgSend
0000000100001ea1        mov        rdi, rax                               ; argument "instance" for
```

DEMO

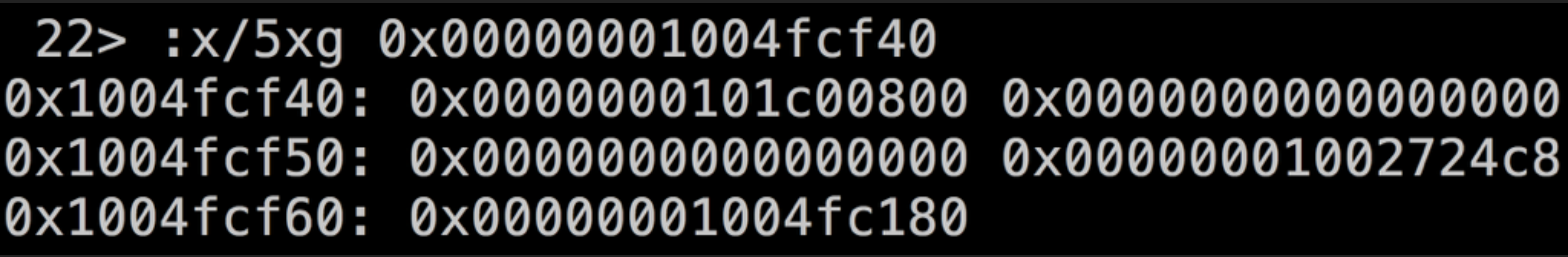


```
 11> var qurl: QueryURLConvertible = ""
qurl: String = ""
 12> sizeof(QueryURLConvertible)
$R0: Int = 40
 13> sizeofValue(qurl)
$R1: Int = 40
```

DEMO

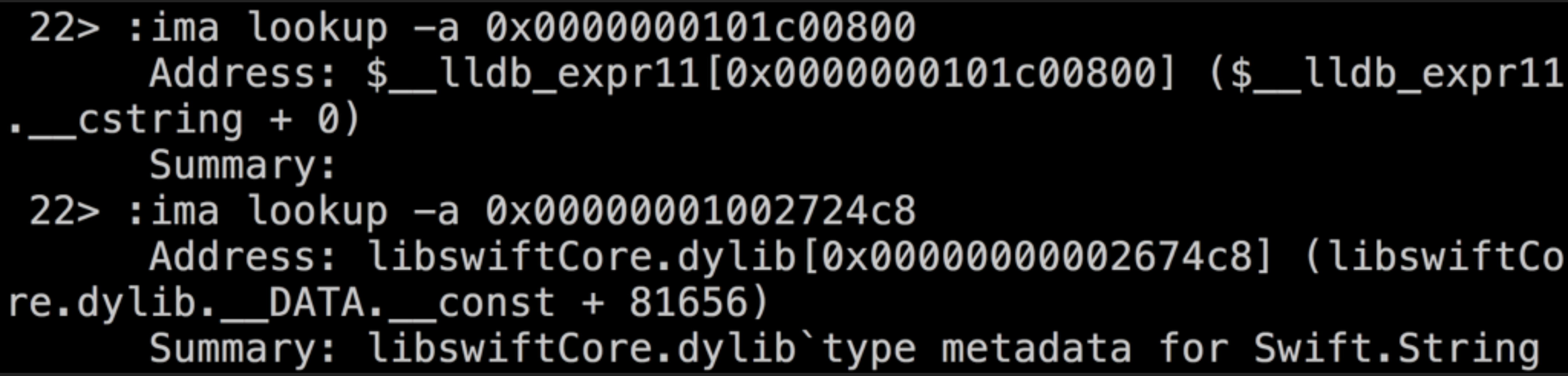


```
 18> func addrOf<T>(inout v: T) {
 19.     withUnsafePointer(&v) { print($0) }
 20. }
 21> addrOf(&qurl)
0x00000001004fcf40
```

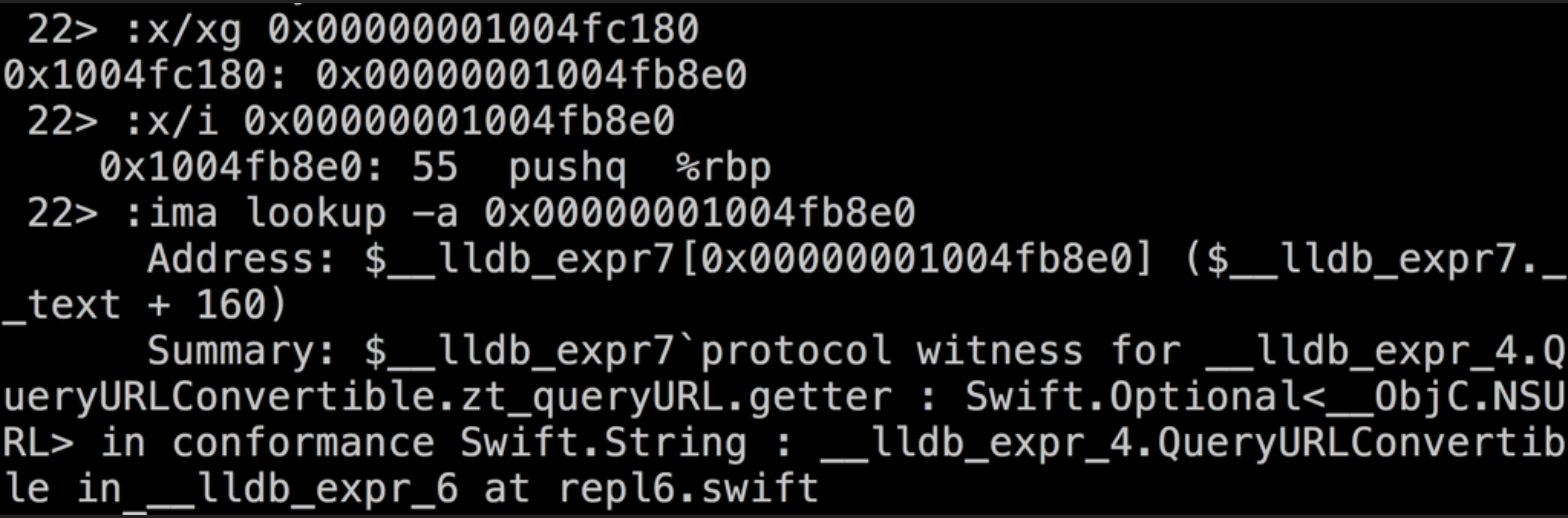


```
 22> :x/5xg 0x00000001004fcf40
0x1004fcf40: 0x0000000101c00800 0x0000000000000000
0x1004fcf50: 0x0000000000000000 0x00000001002724c8
0x1004fcf60: 0x00000001004fc180
```

DEMO

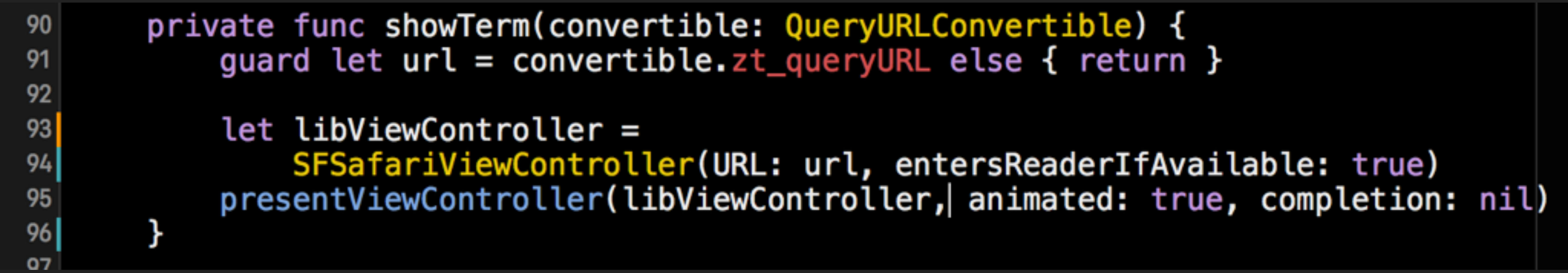


```
 22> :ima lookup -a 0x0000000101c00800
      Address: $__lldb_expr11[0x0000000101c00800] ($__lldb_expr11
.__cstring + 0)
      Summary:
 22> :ima lookup -a 0x00000001002724c8
      Address: libswiftCore.dylib[0x00000000002674c8] (libswiftCo
re.dylib.__DATA.__const + 81656)
      Summary: libswiftCore.dylib`type metadata for Swift.String
```

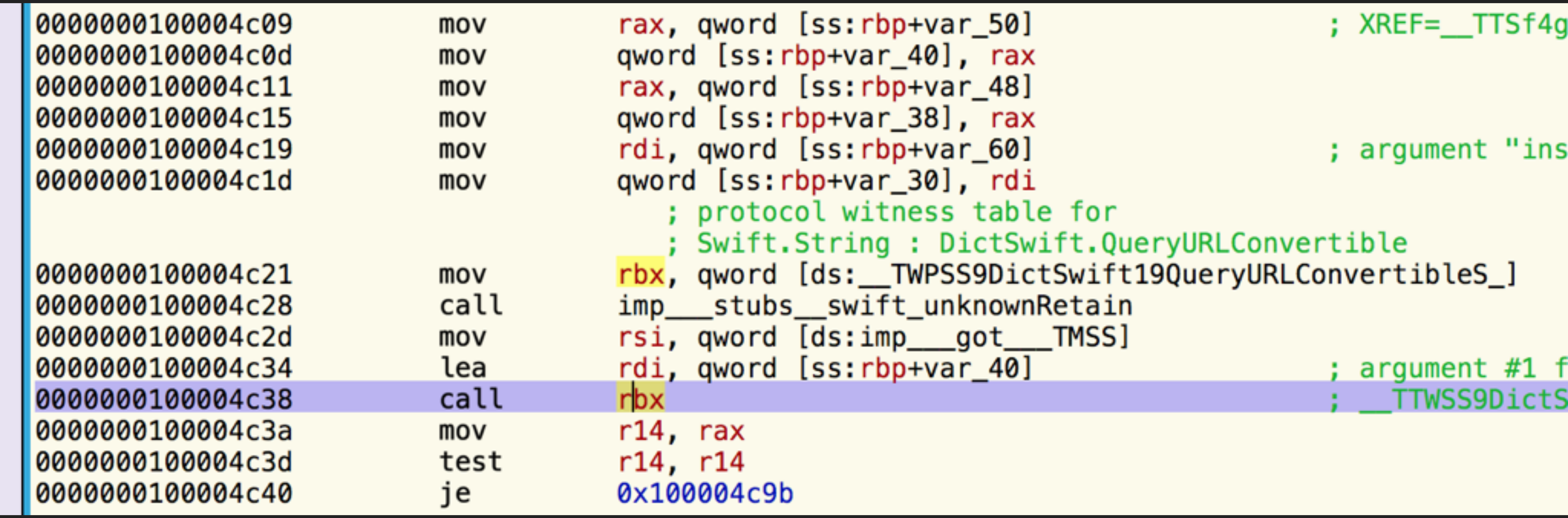


```
 22> :x/xg 0x00000001004fc180
0x1004fc180: 0x00000001004fb8e0
 22> :x/i 0x00000001004fb8e0
    0x1004fb8e0: 55  pushq  %rbp
 22> :ima lookup -a 0x00000001004fb8e0
      Address: $__lldb_expr7[0x00000001004fb8e0] ($__lldb_expr7._
_text + 160)
      Summary: $__lldb_expr7`protocol witness for __lldb_expr_4.Q
ueryURLConvertible.zt_queryURL.getter : Swift.Optional<__ObjC.NSU
RL> in conformance Swift.String : __lldb_expr_4.QueryURLConvertib
le in __lldb_expr_6 at repl6.swift
```

DEMO

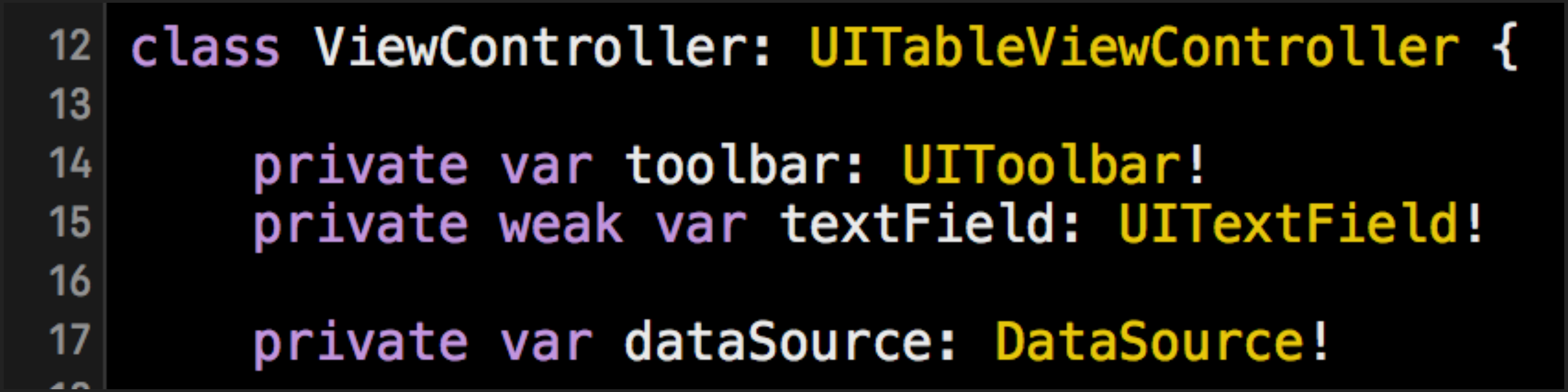


```
    private func showTerm(convertible: QueryURLConvertible) {
        guard let url = convertible.zt_queryURL else { return }

        let libViewController =
            SFSafariViewController(URL: url, entersReaderIfAvailable: true)
        presentViewController(libViewController, animated: true, completion: nil)
    }
```

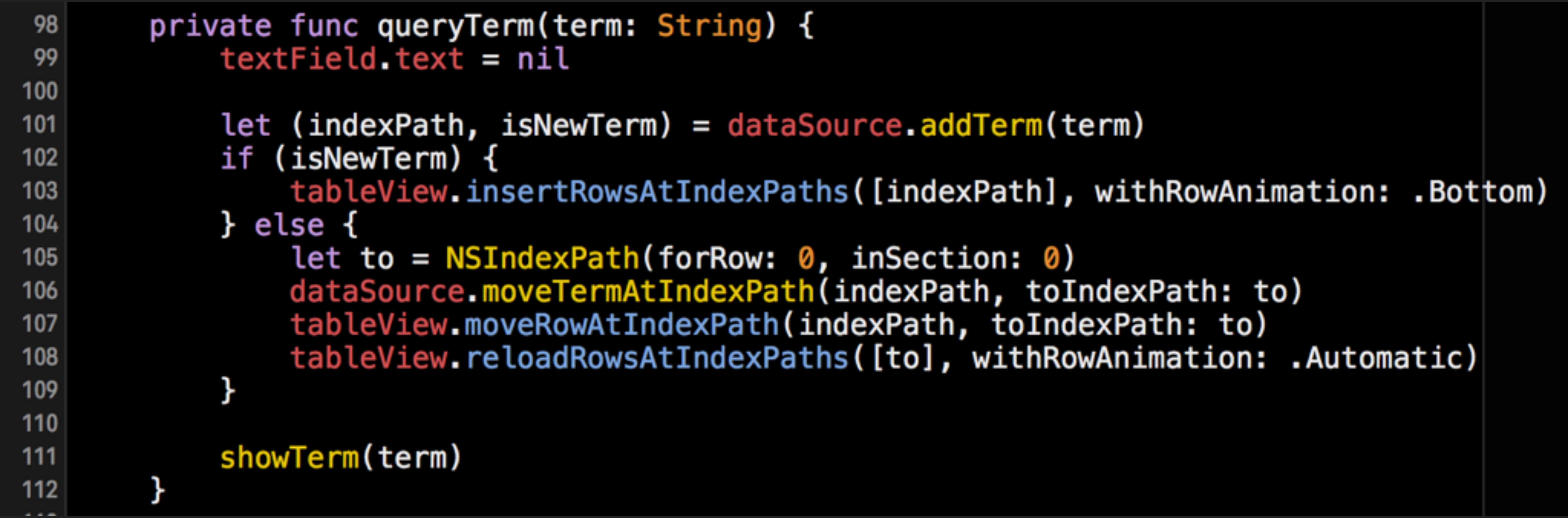


```
0000000100004c09        mov     rax, qword [ss:rbp+var_50]                   ; XREF=__TTSf4g
0000000100004c0d        mov     qword [ss:rbp+var_40], rax
0000000100004c11        mov     rax, qword [ss:rbp+var_48]
0000000100004c15        mov     qword [ss:rbp+var_38], rax
0000000100004c19        mov     rdi, qword [ss:rbp+var_60]                   ; argument "ins
0000000100004c1d        mov     qword [ss:rbp+var_30], rdi
                                    ; protocol witness table for
                                    ; Swift.String : DictSwift.QueryURLConvertible
0000000100004c21        mov     rbx, qword [ds:__TWPSS9DictSwift19QueryURLConvertibleS_]
0000000100004c28        call    imp___stubs__swift_unknownRetain
0000000100004c2d        mov     rsi, qword [ds:imp___got___TMSS]
0000000100004c34        lea     rdi, qword [ss:rbp+var_40]                   ; argument #1 f
0000000100004c38        call    rbx                                          ; __TTWSS9DictS
0000000100004c3a        mov     r14, rax
0000000100004c3d        test    r14, r14
0000000100004c40        je      0x100004c9b
```

DEMO

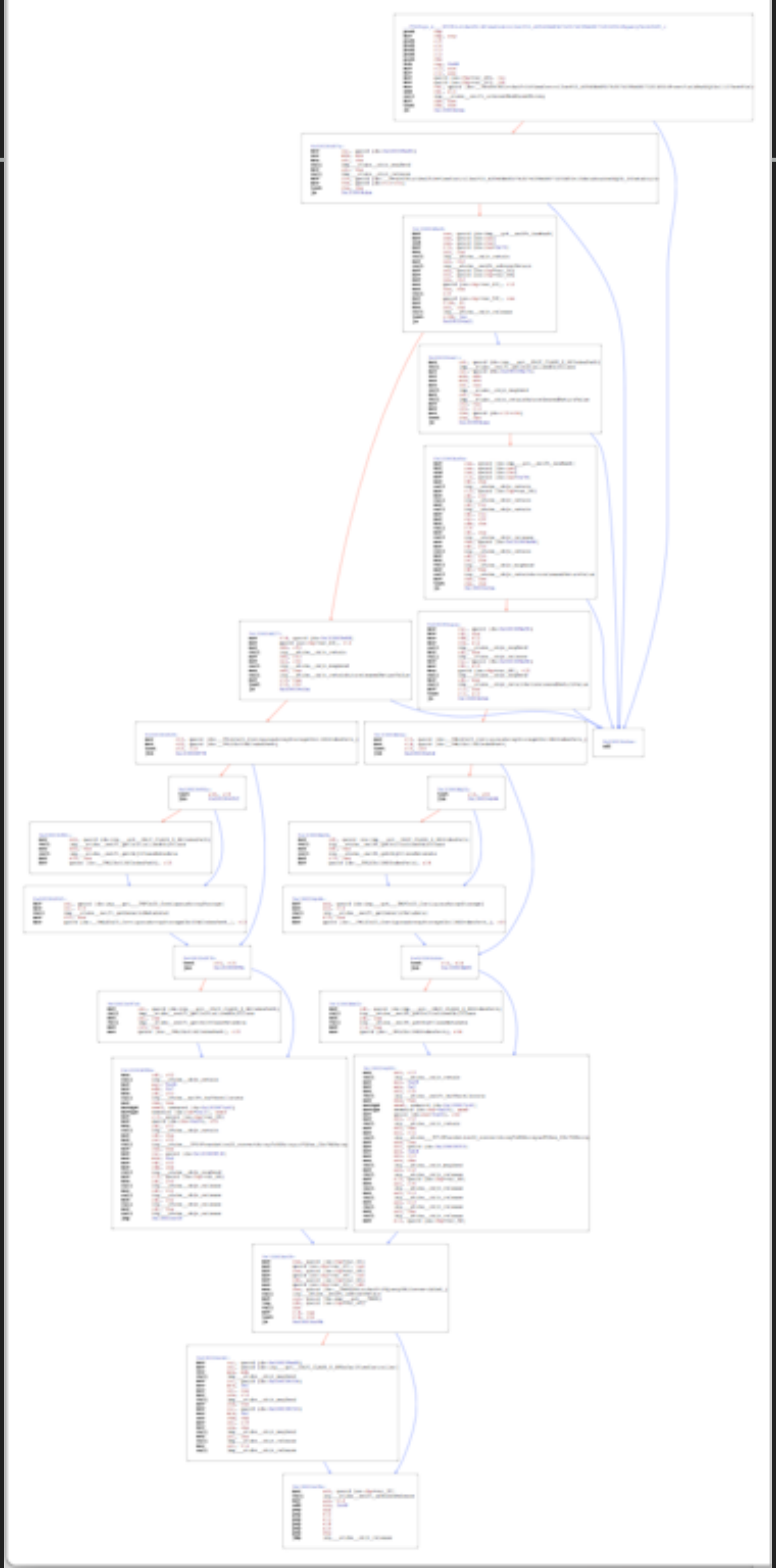


```swift
class ViewController: UITableViewController {

    private var toolbar: UIToolbar!
    private weak var textField: UITextField!

    private var dataSource: DataSource!
```



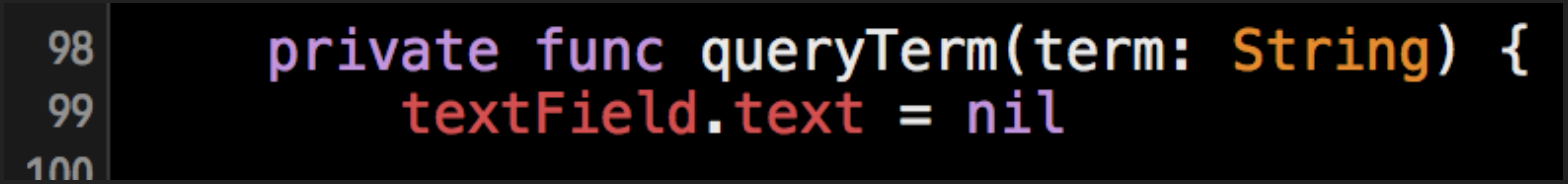
```swift
    private func queryTerm(term: String) {
        textField.text = nil

        let (indexPath, isNewTerm) = dataSource.addTerm(term)
        if (isNewTerm) {
            tableView.insertRowsAtIndexPaths([indexPath], withRowAnimation: .Bottom)
        } else {
            let to = NSIndexPath(forRow: 0, inSection: 0)
            dataSource.moveTermAtIndexPath(indexPath, toIndexPath: to)
            tableView.moveRowAtIndexPath(indexPath, toIndexPath: to)
            tableView.reloadRowsAtIndexPaths([to], withRowAnimation: .Automatic)
        }

        showTerm(term)
    }
```

DEMO

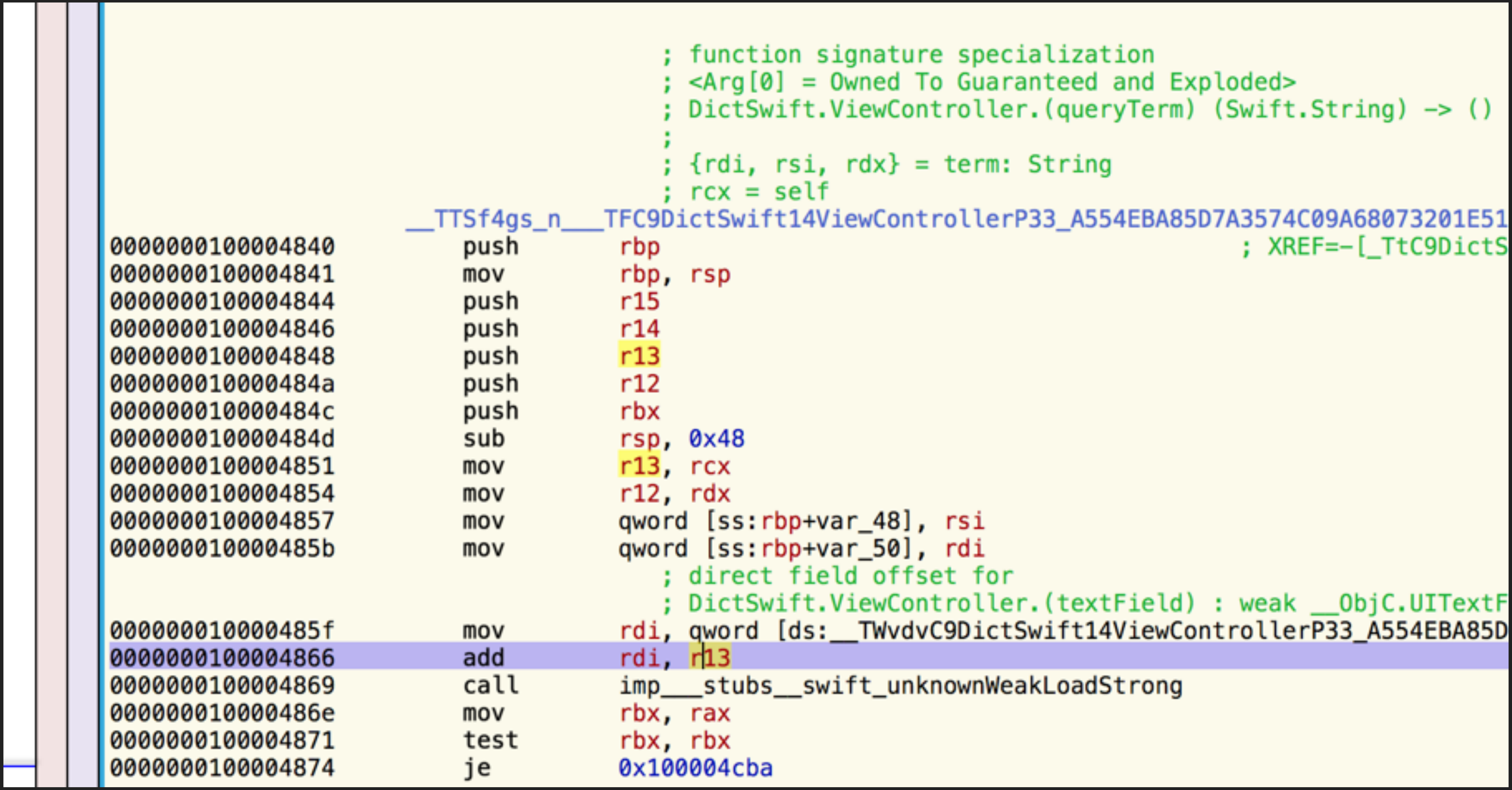


纳尼？！

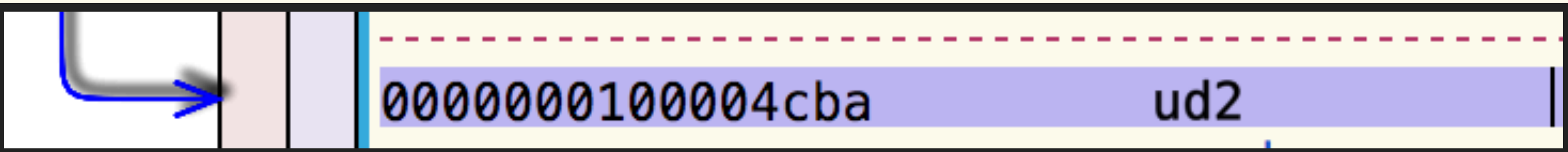
DEMO



```
    private func queryTerm(term: String) {
        textField.text = nil
```

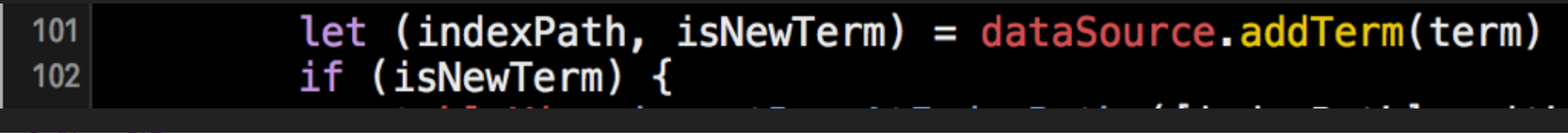


```
                                        ; function signature specialization
                                        ; <Arg[0] = Owned To Guaranteed and Exploded>
                                        ; DictSwift.ViewController.(queryTerm) (Swift.String) -> ()
                                        ;
                                        ; {rdi, rsi, rdx} = term: String
                                        ; rcx = self
                     __TTSf4gs_n___TFC9DictSwift14ViewControllerP33_A554EBA85D7A3574C09A68073201E51
0000000100004840         push       rbp                                             ; XREF=-[_TtC9DictS
0000000100004841         mov        rbp, rsp
0000000100004844         push       r15
0000000100004846         push       r14
0000000100004848         push       r13
000000010000484a         push       r12
000000010000484c         push       rbx
000000010000484d         sub        rsp, 0x48
0000000100004851         mov        r13, rcx
0000000100004854         mov        r12, rdx
0000000100004857         mov        qword [ss:rbp+var_48], rsi
000000010000485b         mov        qword [ss:rbp+var_50], rdi
                                        ; direct field offset for
                                        ; DictSwift.ViewController.(textField) : weak __ObjC.UITextF
000000010000485f         mov        rdi, qword [ds:__TWvdvC9DictSwift14ViewControllerP33_A554EBA85D
0000000100004866         add        rdi, r13
0000000100004869         call       imp___stubs__swift_unknownWeakLoadStrong
000000010000486e         mov        rbx, rax
0000000100004871         test       rbx, rbx
0000000100004874         je         0x100004cba
```

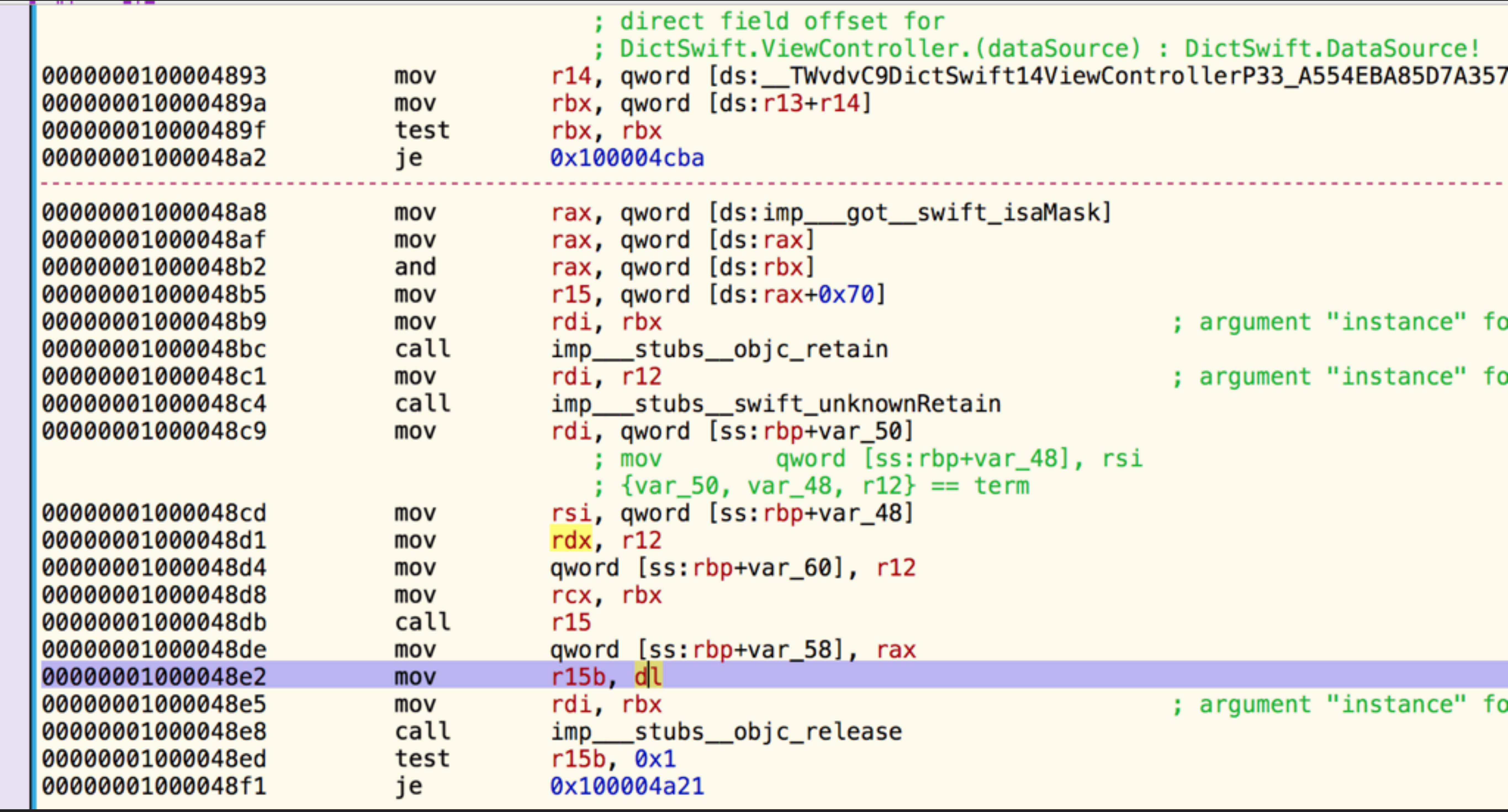


```
0000000100004cba         ud2
```

DEMO



```
        let (indexPath, isNewTerm) = dataSource.addTerm(term)
        if (isNewTerm) {
```



```
                                          ; direct field offset for
                                          ; DictSwift.ViewController.(dataSource) : DictSwift.DataSource!
0000000100004893         mov         r14, qword [ds:__TWvdvC9DictSwift14ViewControllerP33_A554EBA85D7A357
000000010000489a         mov         rbx, qword [ds:r13+r14]
000000010000489f         test        rbx, rbx
00000001000048a2         je          0x100004cba
-----------------------------------------------------------------------------------------------------------
00000001000048a8         mov         rax, qword [ds:imp___got__swift_isaMask]
00000001000048af         mov         rax, qword [ds:rax]
00000001000048b2         and         rax, qword [ds:rbx]
00000001000048b5         mov         r15, qword [ds:rax+0x70]
00000001000048b9         mov         rdi, rbx                                   ; argument "instance" fo
00000001000048bc         call        imp___stubs__objc_retain
00000001000048c1         mov         rdi, r12                                   ; argument "instance" fo
00000001000048c4         call        imp___stubs__swift_unknownRetain
00000001000048c9         mov         rdi, qword [ss:rbp+var_50]
                                          ; mov        qword [ss:rbp+var_48], rsi
                                          ; {var_50, var_48, r12} == term
00000001000048cd         mov         rsi, qword [ss:rbp+var_48]
00000001000048d1         mov         rdx, r12
00000001000048d4         mov         qword [ss:rbp+var_60], r12
00000001000048d8         mov         rcx, rbx
00000001000048db         call        r15
00000001000048de         mov         qword [ss:rbp+var_58], rax
00000001000048e2         mov         r15b, dl
00000001000048e5         mov         rdi, rbx                                   ; argument "instance" fo
00000001000048e8         call        imp___stubs__objc_release
00000001000048ed         test        r15b, 0x1
00000001000048f1         je          0x100004a21
```

逆向工程理论基础

- C / C++ / Objective-C / Swift
- Assembly (x86, x86_64, arm / thumb, arm64)
- 平台 ABI / 语言特定 ABI
- 编译器优化
- 操作系统

逆向工程方法和工具

- 静态分析
  - Hopper Disassembler
  - IDA Pro
  - otool
  - class-dump

- 动态调试
  - lldb / gdb
  - F-Script
  - cycript

参考资料

- Wikipedia
- System V Application Binary Interface (AMD64)
- Procedure Call Standard for the ARM 64-bit Architecture
- iOS ABI Function Call Guide
- The Swift ABI
- The Swift Calling Convention
- Friday Q&A

相关资源

- https://github.com/apple/swift
- https://github.com/hankbao/DictObjc
- https://github.com/hankbao/DictSwift

THANKS

Q & A