

Memory Management

Memory Management without ARC

1. GC (Garbage Collection)

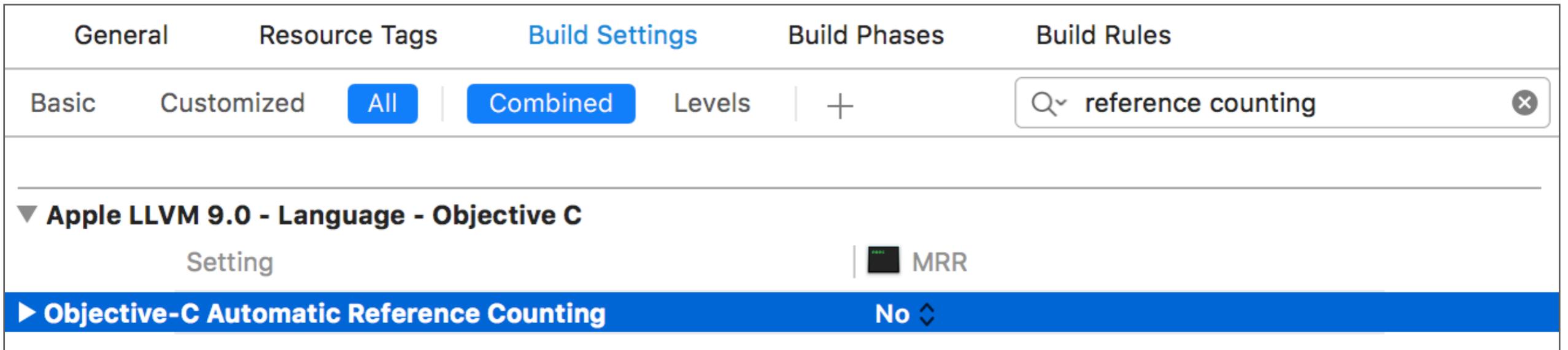
- 정기적으로 Garbage Collector 가 동작하여 더이상 사용되지 않는 메모리를 반환하는 방식
- OS X 에서만 지원했었으나 버전 10.8 (Mountain Lion) 부터 deprecated

2. MRR (Manual Retain-Release) / MRC (Manual Reference Counting)

- RC(Reference Counting) 를 통해 메모리를 수동으로 관리하는 방식
- retain / release / autorelease 등의 메모리 관리 코드를 직접 호출
- 개발자가 명시적으로 RC 를 증가시키고 감소시키는 작업 수행

RC에 대한 이해 필요 (Reference Counting / Retain Count / Reference Count)

Objective-C에서는 ARC 해제 가능



The screenshot shows the Xcode interface with the "Build Settings" tab selected. A search bar at the top right contains the text "reference counting". Below it, under the "Apple LLVM 9.0 - Language - Objective C" section, there is a setting for "Objective-C Automatic Reference Counting" which is set to "No".

General	Resource Tags	Build Settings	Build Phases	Build Rules
Basic	Customized	All Combined	Levels +	<input type="text" value="reference counting"/> (X)
▼ Apple LLVM 9.0 - Language - Objective C				
Setting		 MRR		
► Objective-C Automatic Reference Counting		No ◊		

Reference Counting

```
int main(int argc, const char * argv[]) {
```

```
    Person *man = [[Person alloc] init];
```

_____ count : 1

```
    [man doSomething];
```

```
    [man retain];
```

_____ count : 2

```
    [man doSomething];
```

```
// [man release];
```

_____ count : 2

```
    [man doSomething];
```

_____ count : 1

```
    [man release];
```

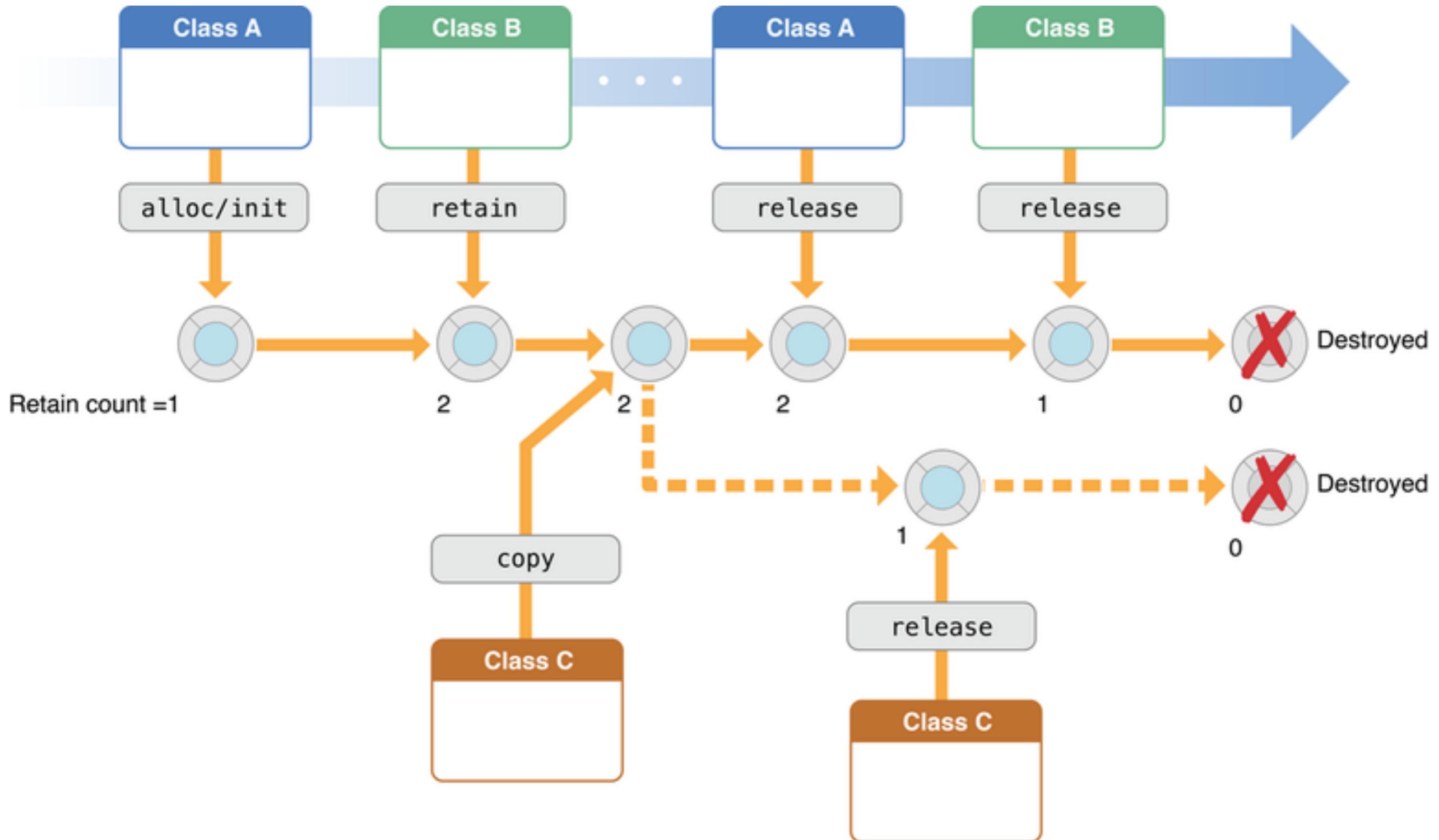
_____ count : 0

```
    [man release];
```

```
    return 0;
```

```
}
```

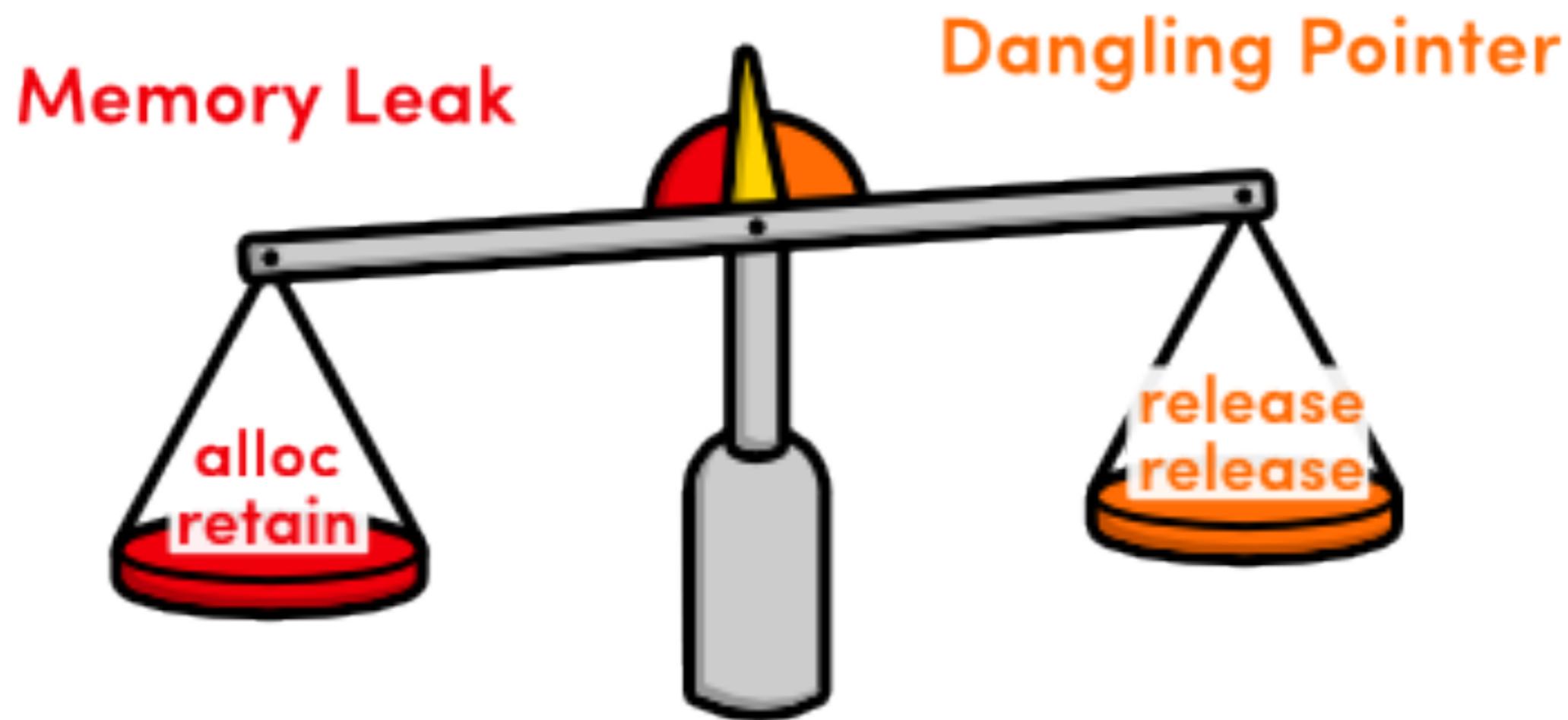
Reference Counting (Obj-C)



Leak vs Dangling Pointer

카운트 할당과 해제는 균형이 맞아야 함

- alloc , retain 이 많을 경우 Memory Leak 발생
- release 가 많을 경우 Dangling Pointer (허상, 고아) 발생



Memory Management Is Hard

- Lots of rules and conventions
- High hurdles for new developers
- Constant attention for existing developers
- Requires perfection



Memory Management Is Hard

- Instruments
 - Allocations, Leaks, Zombies
- Xcode Static Analyzer
- Heap
- ObjectAlloc
- vmmap
- MallocScribble
- debugger watchpoints
- ...and lots more



Programming with Retain/Release



Xcode Static Analyzer

```
NSObject *objectID = 0;  
  
for (NSUInteger i=0; i < count; ++i) {    ← Looping back to the head of the loop  
    NSObject *object = [trackedElements objectAtIndex:i];  
    if ([object isKindOfClass:[NSString class]])  
    {  
        objectID = [[NSString alloc] initWithString:aString];  
        ← Method returns an Objective-C object with a +1 retain count (owning reference)  
    }  
    if (objectID != nil)  
    {  
        [objectID release];  
        ← Object released  
        ← Reference-counted object is used after it is released  
    }  
}
```

Xcode Static Analyzer

```
13 int main(int argc, const char * argv[]) {  
14     Person *man = [[Person alloc] init];  
15     [man doSomething];  
16  
17     return 0;           ➔ 1. Method returns an Objective-C object with a +1 retain count  
18 }
```

➔ 2. Object leaked: object allocated and stored into 'man' is not referenced later in this execution path and has a retain count of +1

[Memory Leak]

```
13 int main(int argc, const char * argv[]) {  
14     Person *man = [[Person alloc] init];  
15     [man doSomething];  
16     [man release];          ➔ 1. Method returns an Objective-C object with a +1 retain count  
17  
18     [man doSomething];      ➔ 2. Object released  
19     [man doSomething];  
20     [man doSomething];  
21  
22     return 0;  
23 }  
24
```

➔ 3. Reference-counted object is used after it is released

[Released Object]

ARC

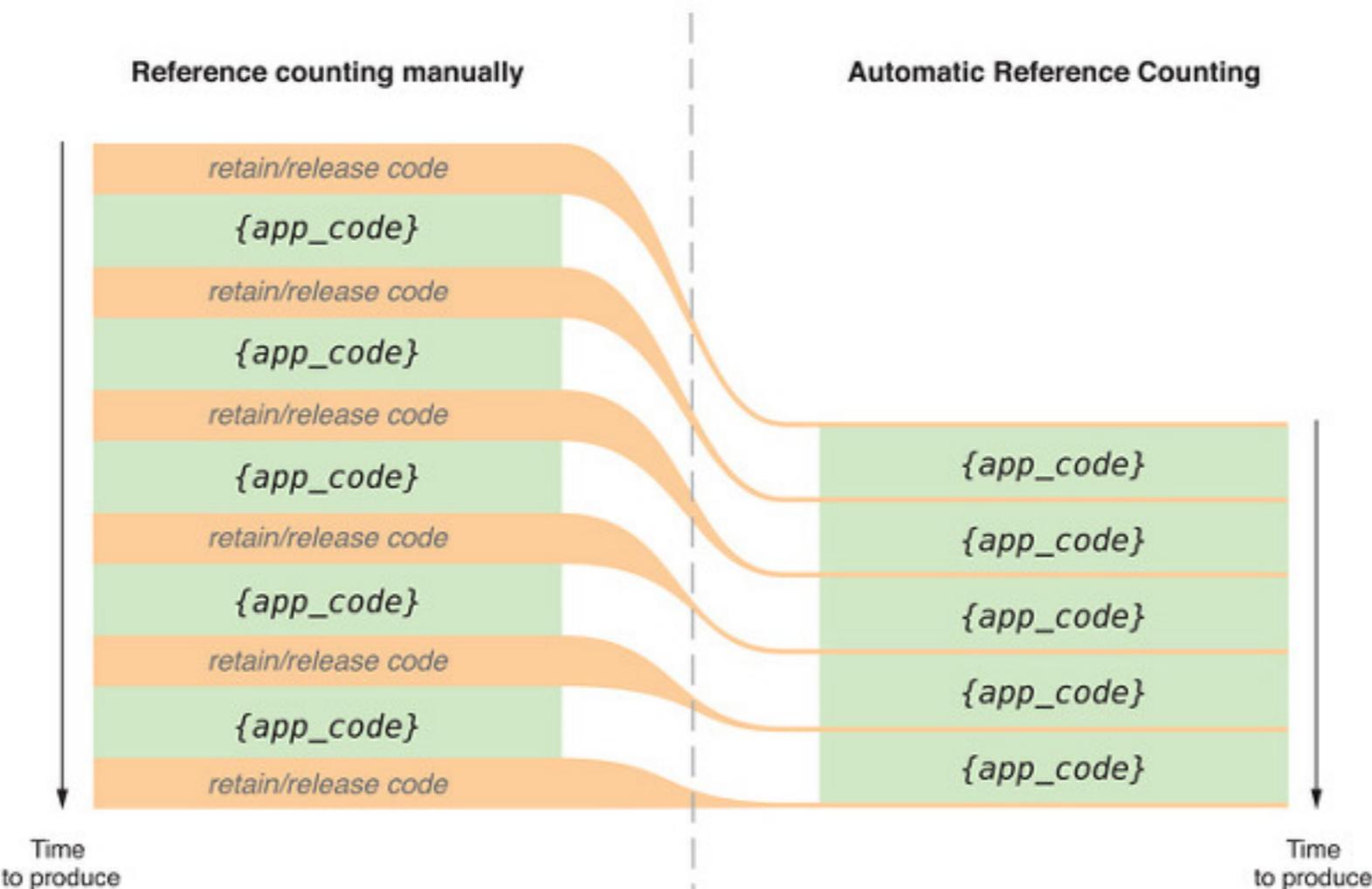
ARC (Automatic Reference Counting)

RC 자동 관리 방식 (WWDC 2011 발표)

컴파일러가 개발자를 대신하여 메모리 관리 코드를 적절한 위치에 자동으로 삽입

GC 처럼 런타임이 아닌 컴파일 단에서 처리 (Heap에 대한 스캔 불필요 / 앱 일시 정지 현상 없음)

메모리 관리 이슈를 줄이고 개발자가 코딩 자체에 집중할 수 있도록 함



ARC (Automatic Reference Counting)

ARC는 클래스의 인스턴스에만 적용 (Class - Reference 타입, Struct / Enum - Value 타입)

활성화된 참조카운트가 하나라도 있을 경우 메모리에서 해제 되지 않음

참조 타입

- 강한 참조 (Strong) : 기본값. 참조될 때마다 참조 카운트 1 증가
- 약한 참조 (Weak), 미소유 참조 (Unowned) : 참조 카운트를 증가시키지 않음

강한 순환 참조 (Strong Reference Cycles)에 대한 주의 필요

	Var	Let	Optional	Non-Optional
Strong	👍	👍	👍	👍
Weak	👍	🚫	👍	🚫
Unowned	👍	👍	🚫	👍

```
// Reference Counting
// Class

class Point {
    var x, y: Double
    func draw() { ... }
}

let point1 = Point(x: 0, y: 0)
let point2 = point1
point2.x = 5
// use `point1`
// use `point2`
```

```
// Reference Counting  
// Class  
  
class Point {  
    var x, y: Double  
    func draw() { ... }  
}
```

```
let point1 = Point(x: 0, y: 0)  
let point2 = point1  
point2.x = 5  
// use `point1`  
// use `point2`
```

```
// Reference Counting  
// Class (generated code)
```

```
class Point {  
    var refCount: Int  
    var x, y: Double  
    func draw() { ... }  
}
```

```
let point1 = Point(x: 0, y: 0)  
let point2 = point1  
    retain(point2)  
point2.x = 5  
// use `point1`  
    release(point1)  
// use `point2`  
    release(point2)
```

```
// Reference Counting  
// Class (generated code)  
  
class Point {  
    var refCount: Int  
    var x, y: Double  
    func draw() { ... }  
}
```

```
let point1 = Point(x: 0, y: 0)  
let point2 = point1  
retain(point2)  
point2.x = 5  
// use `point1`  
release(point1)  
// use `point2`  
release(point2)
```

Stack

```
point1:  
point2:
```

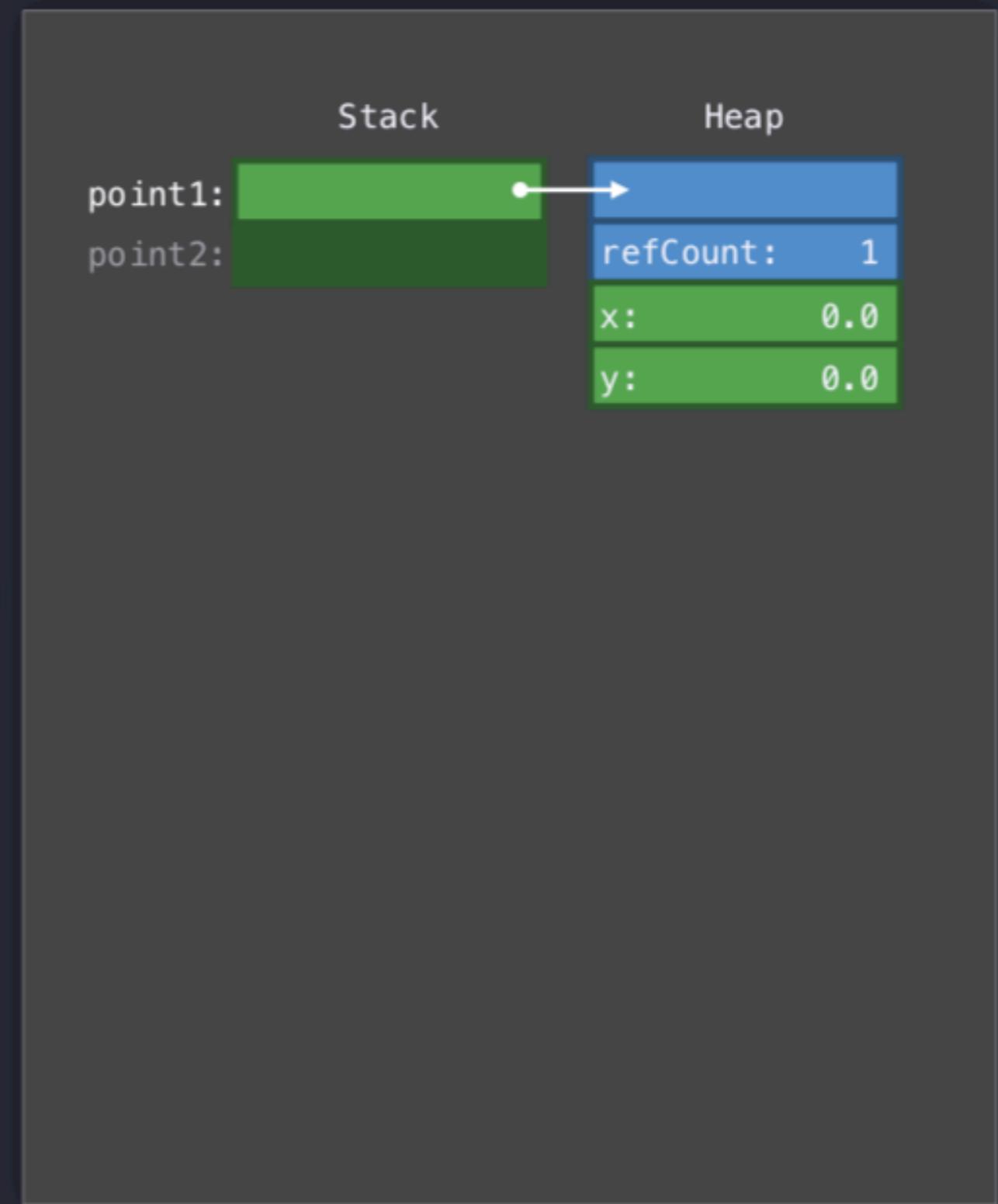
```
// Reference Counting  
// Class (generated code)  
  
class Point {  
    var refCount: Int  
    var x, y: Double  
    func draw() { ... }  
}
```

```
let point1 = Point(x: 0, y: 0)  
let point2 = point1  
retain(point2)  
point2.x = 5  
// use `point1`  
release(point1)  
// use `point2`  
release(point2)
```

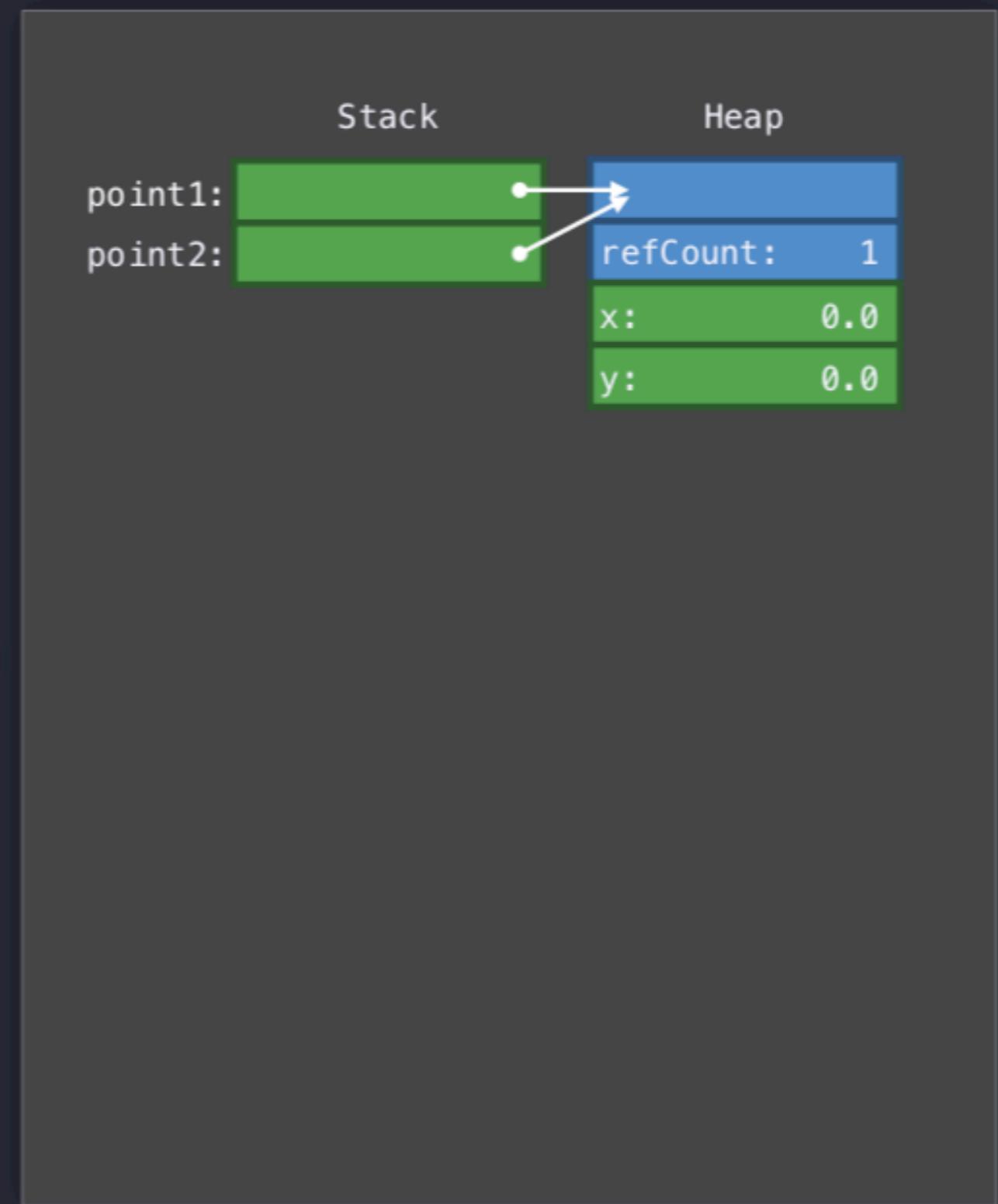
Stack	Heap
point1:	
point2:	

```
// Reference Counting  
// Class (generated code)  
  
class Point {  
    var refCount: Int  
    var x, y: Double  
    func draw() { ... }  
}
```

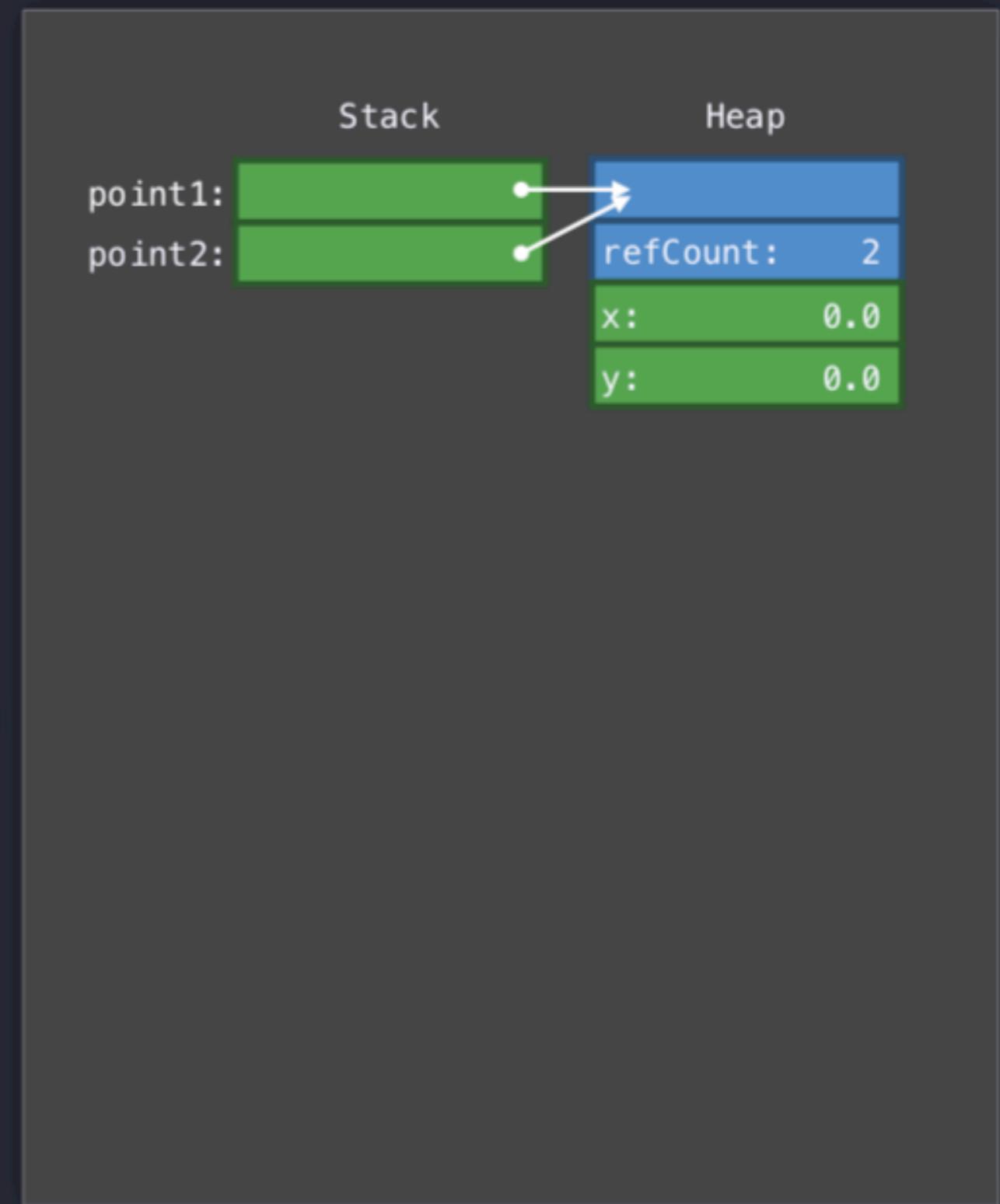
```
let point1 = Point(x: 0, y: 0)  
let point2 = point1  
retain(point2)  
point2.x = 5  
// use `point1`  
release(point1)  
// use `point2`  
release(point2)
```



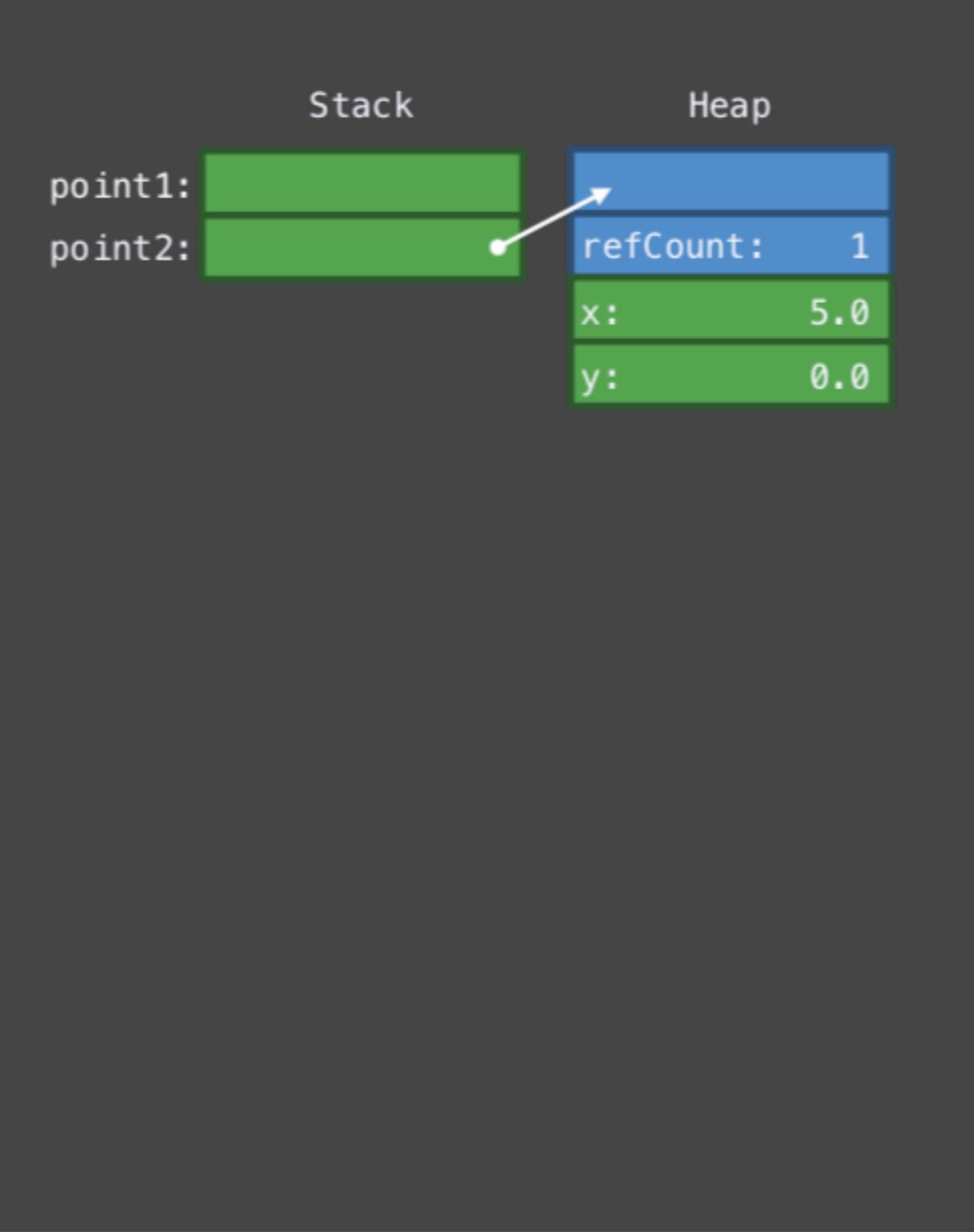
```
// Reference Counting  
// Class (generated code)  
  
class Point {  
    var refCount: Int  
    var x, y: Double  
    func draw() { ... }  
}  
  
let point1 = Point(x: 0, y: 0)  
let point2 = point1  
retain(point2)  
point2.x = 5  
// use `point1`  
release(point1)  
// use `point2`  
release(point2)
```



```
// Reference Counting  
// Class (generated code)  
  
class Point {  
    var refCount: Int  
    var x, y: Double  
    func draw() { ... }  
}  
  
  
let point1 = Point(x: 0, y: 0)  
let point2 = point1  
    retain(point2)  
  
point2.x = 5  
// use `point1`  
release(point1)  
// use `point2`  
release(point2)
```



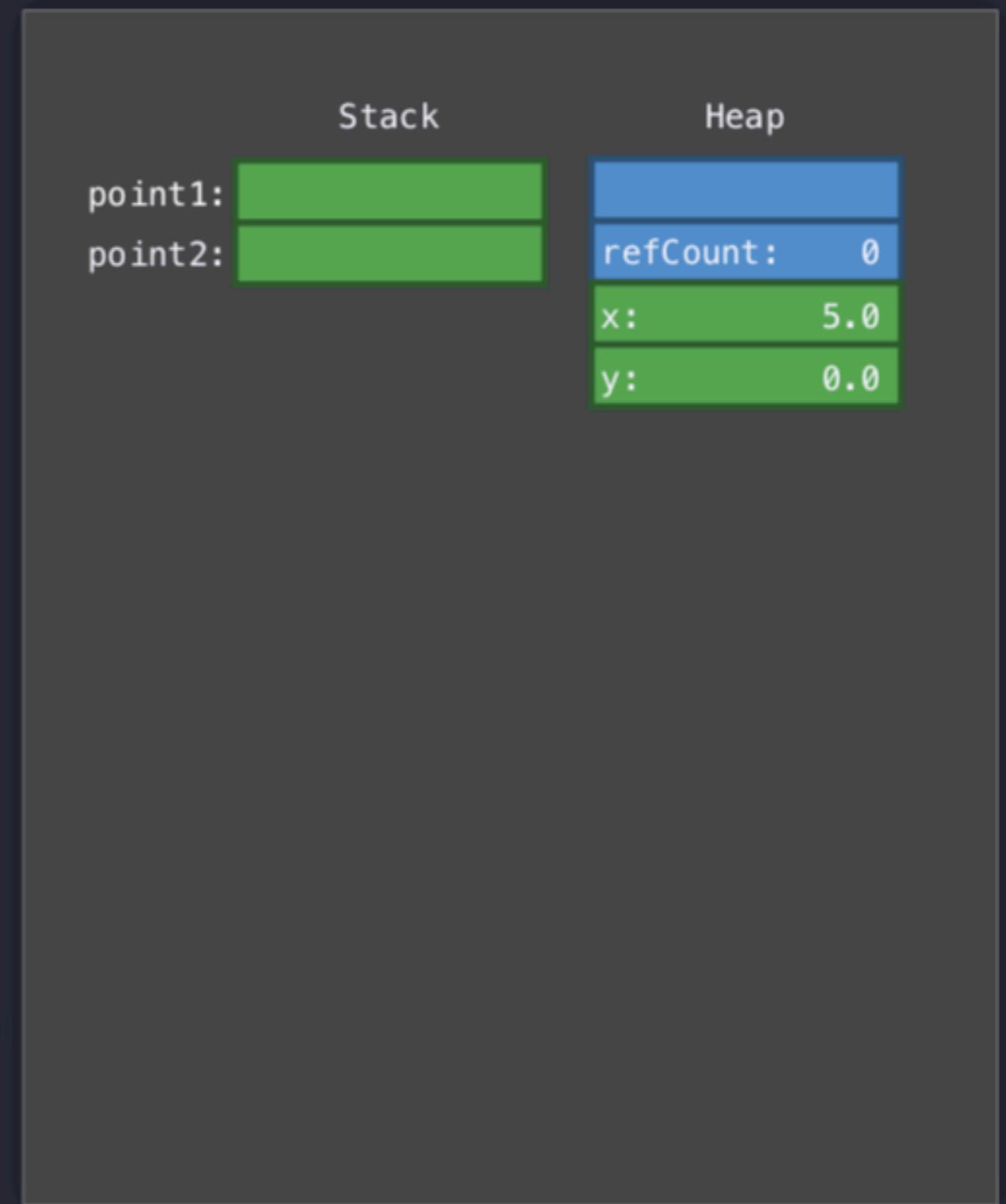
```
// Reference Counting  
// Class (generated code)  
  
class Point {  
    var refCount: Int  
    var x, y: Double  
    func draw() { ... }  
}  
  
let point1 = Point(x: 0, y: 0)  
let point2 = point1  
retain(point2)  
point2.x = 5  
// use `point1`  
release(point1)  
// use `point2`  
release(point2)
```



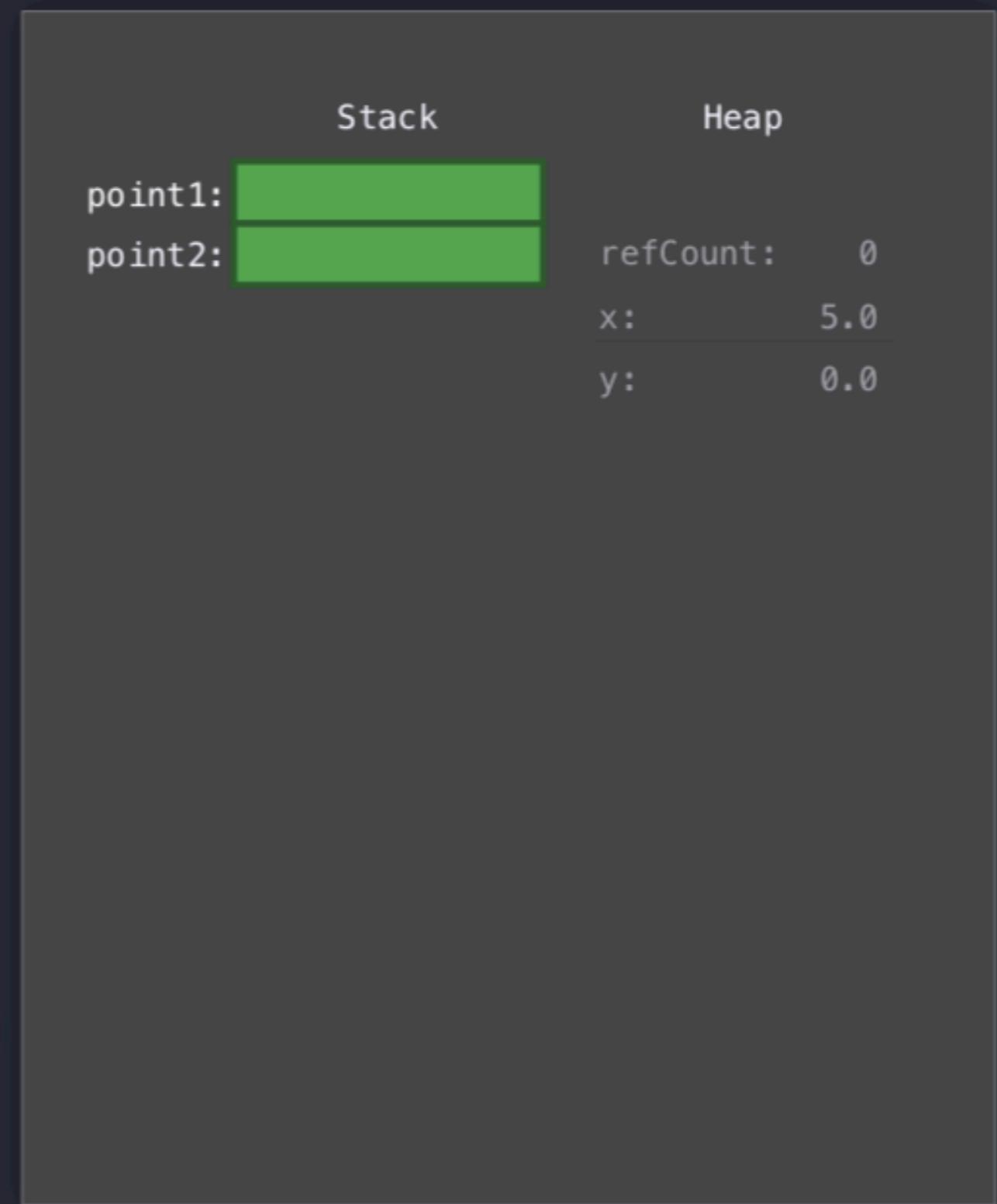
```
// Reference Counting
// Class (generated code)

class Point {
    var refCount: Int
    var x, y: Double
    func draw() { ... }
}

let point1 = Point(x: 0, y: 0)
let point2 = point1
retain(point2)
point2.x = 5
// use `point1`
release(point1)
// use `point2`
release(point2)
```



```
// Reference Counting  
// Class (generated code)  
  
class Point {  
    var refCount: Int  
    var x, y: Double  
    func draw() { ... }  
}  
  
let point1 = Point(x: 0, y: 0)  
let point2 = point1  
retain(point2)  
point2.x = 5  
// use `point1`  
release(point1)  
// use `point2`  
release(point2)
```



```
// Reference Counting
// Class (generated code)

class Point {
    var refCount: Int
    var x, y: Double
    func draw() { ... }
}

let point1 = Point(x: 0, y: 0)
let point2 = point1
retain(point2)
point2.x = 5
// use `point1`
release(point1)
// use `point2`
release(point2)
```

Stack	Heap
point1:	
point2:	
	refCount: 0
	x: 5.0
	y: 0.0

ARC in Struct ?

```
// Allocation  
// Struct  
  
struct Point {  
    var x, y: Double  
    func draw() { ... }  
}  
  
let point1 = Point(x: 0, y: 0)  
var point2 = point1  
point2.x = 5  
// use `point1`  
// use `point2`
```

```
// Allocation  
// Struct  
  
struct Point {  
    var x, y: Double  
    func draw() { ... }  
}
```

```
let point1 = Point(x: 0, y: 0)  
var point2 = point1  
point2.x = 5  
// use `point1`  
// use `point2`
```

Stack

```
point1: x:  
y:  
point2: x:  
y:
```

```
// Allocation  
// Struct  
  
struct Point {  
    var x, y: Double  
    func draw() { ... }  
}
```

```
let point1 = Point(x: 0, y: 0)  
var point2 = point1  
point2.x = 5  
// use `point1`  
// use `point2`
```

Stack

point1:	x:	0.0
	y:	0.0
point2:	x:	
	y:	

```
// Allocation  
// Struct  
  
struct Point {  
    var x, y: Double  
    func draw() { ... }  
}
```

```
let point1 = Point(x: 0, y: 0)  
var point2 = point1  
  
point2.x = 5  
// use `point1`  
// use `point2`
```

Stack	
point1:	x: 0.0
	y: 0.0
point2:	x: 0.0
	y: 0.0

```
// Allocation  
// Struct  
  
struct Point {  
    var x, y: Double  
    func draw() { ... }  
}  
  
let point1 = Point(x: 0, y: 0)  
var point2 = point1  
point2.x = 5  
// use `point1`  
// use `point2`
```

Stack	
point1:	x: 0.0
	y: 0.0
point2:	x: 5.0
	y: 0.0

```
// Allocation  
// Struct  
  
struct Point {  
    var x, y: Double  
    func draw() { ... }  
}  
  
let point1 = Point(x: 0, y: 0)  
var point2 = point1  
point2.x = 5  
// use `point1`  
// use `point2`
```

Stack

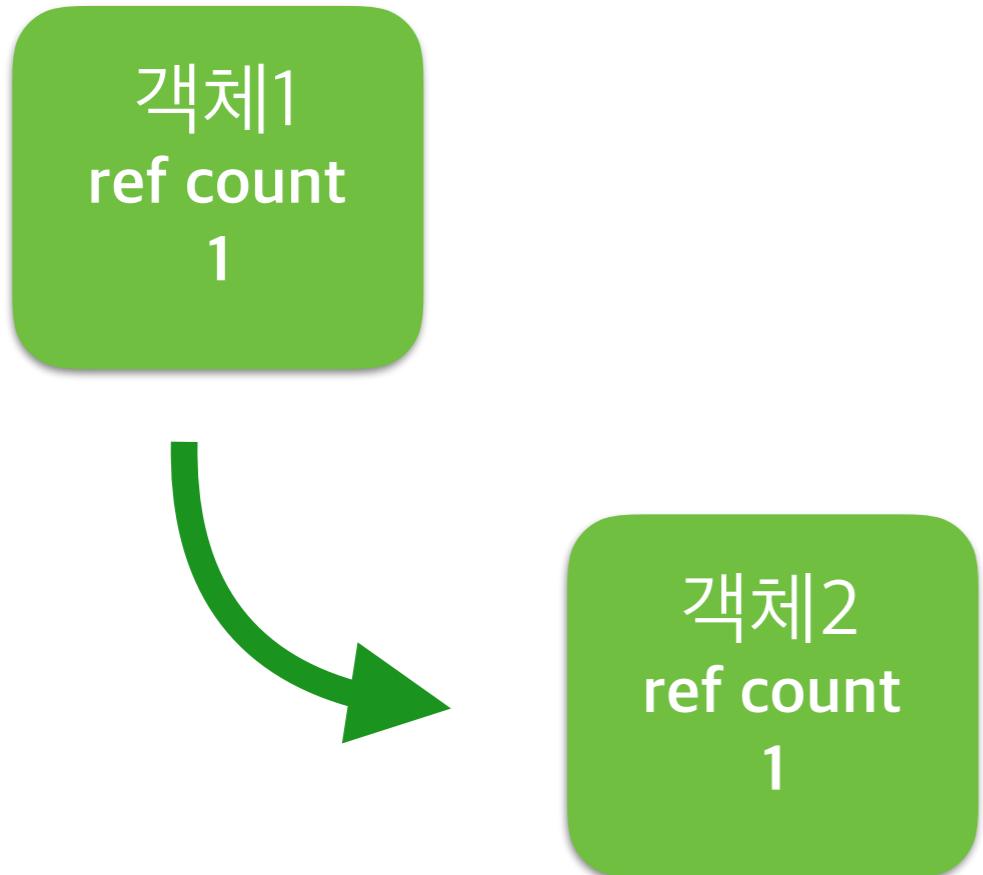
point1: x:	0.0
	y: 0.0
point2: x:	5.0
	y: 0.0

Strong Reference Cycle

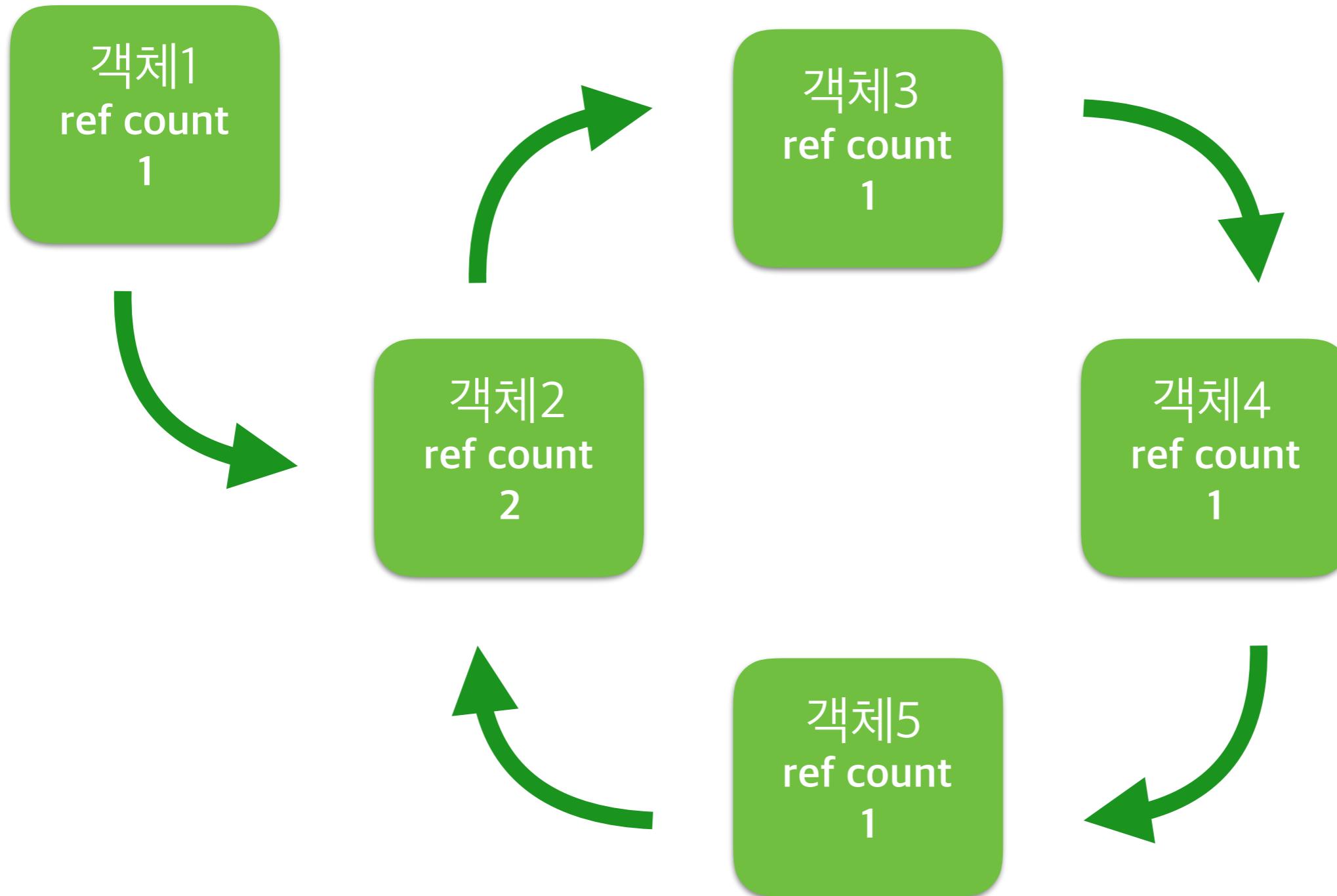
Strong Reference Cycle

- 객체에 접근 가능한 모든 연결을 끊었음에도 순환 참조로 인해 활성화된 참조 카운트가 남아 있어 메모리 누수가 발생하는 현상
- 앱의 실행이 느려지거나 오동작 또는 오류를 발생시키는 원인이 됨

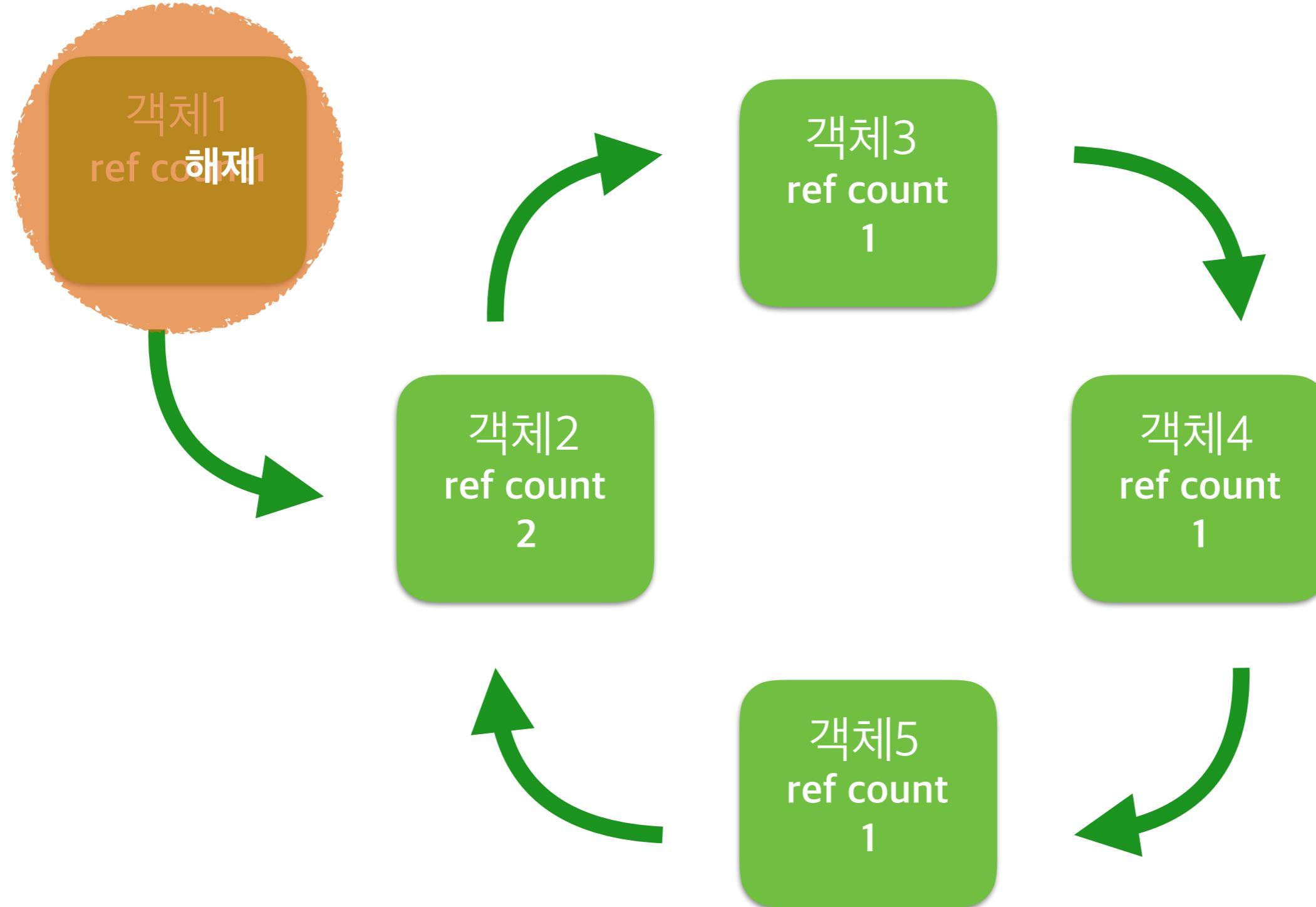
Strong Reference Cycle



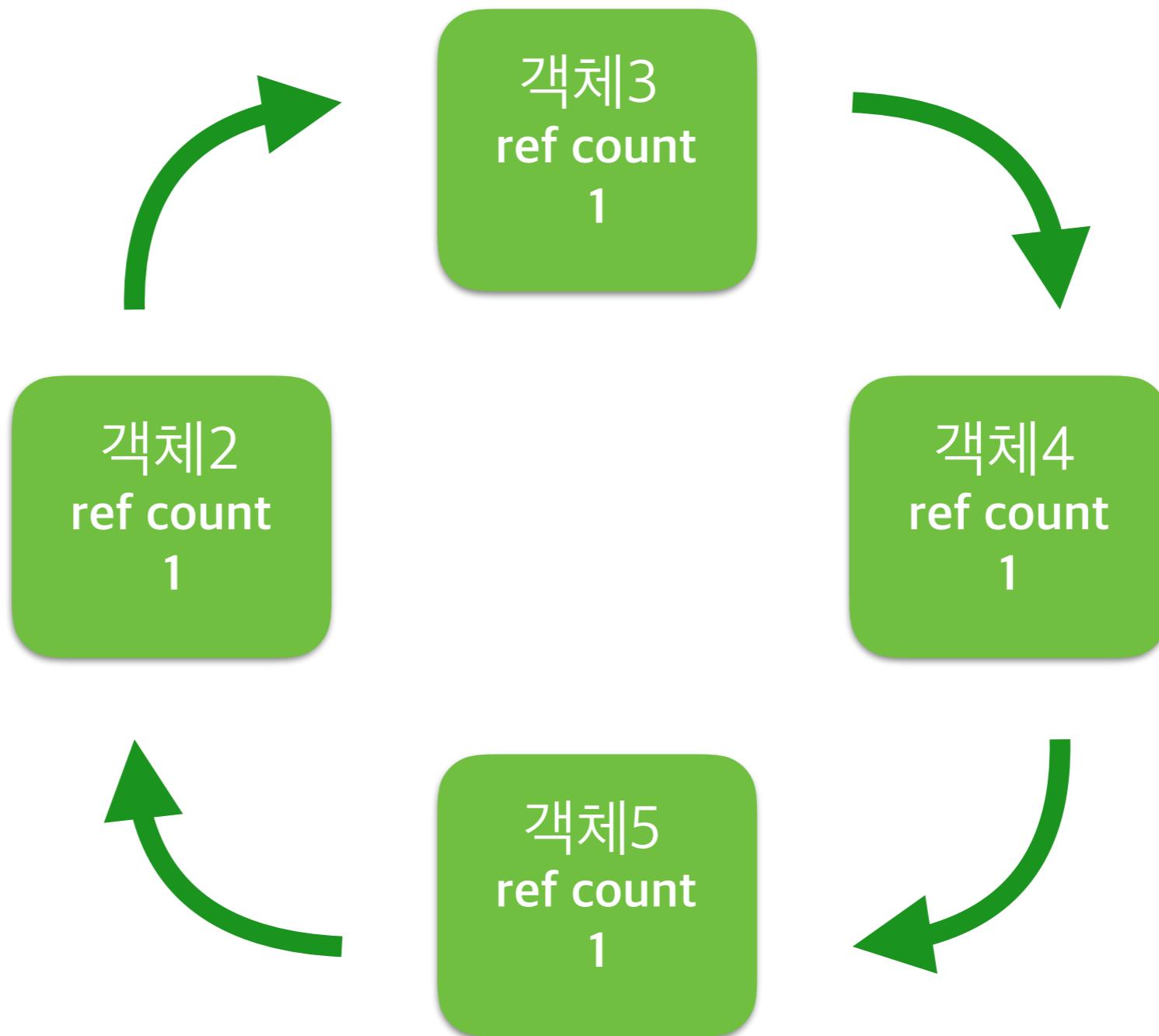
Strong Reference Cycle



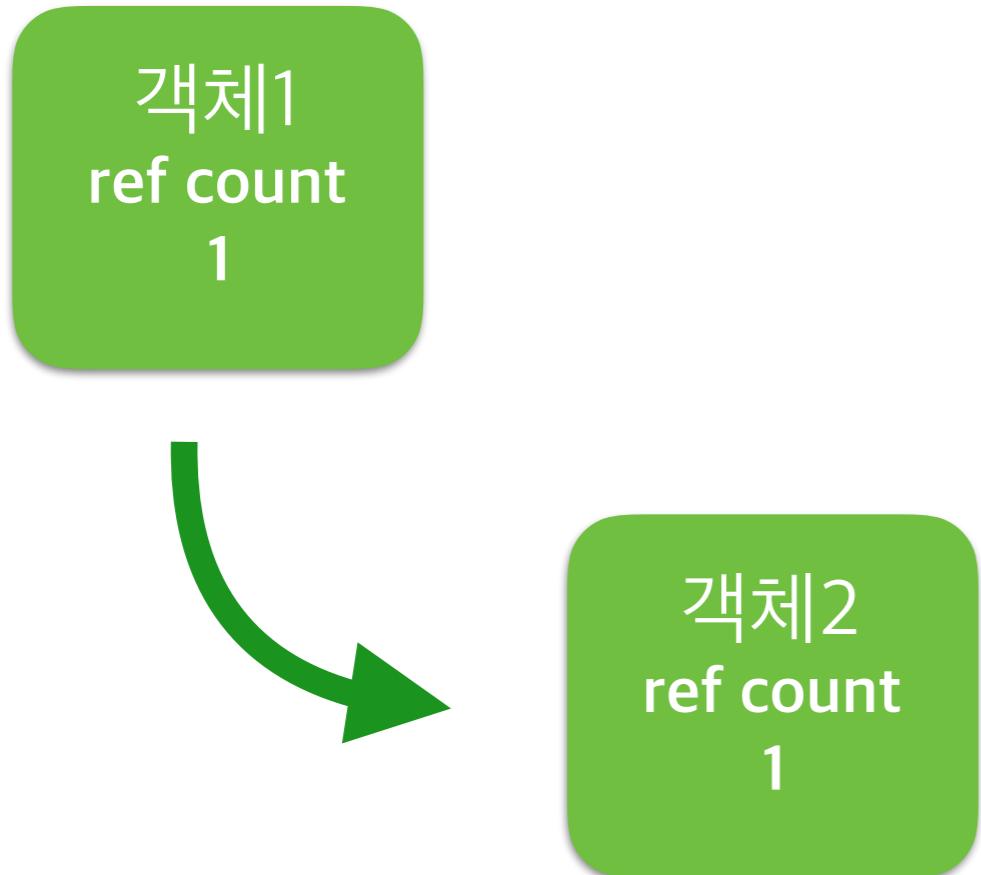
Strong Reference Cycle



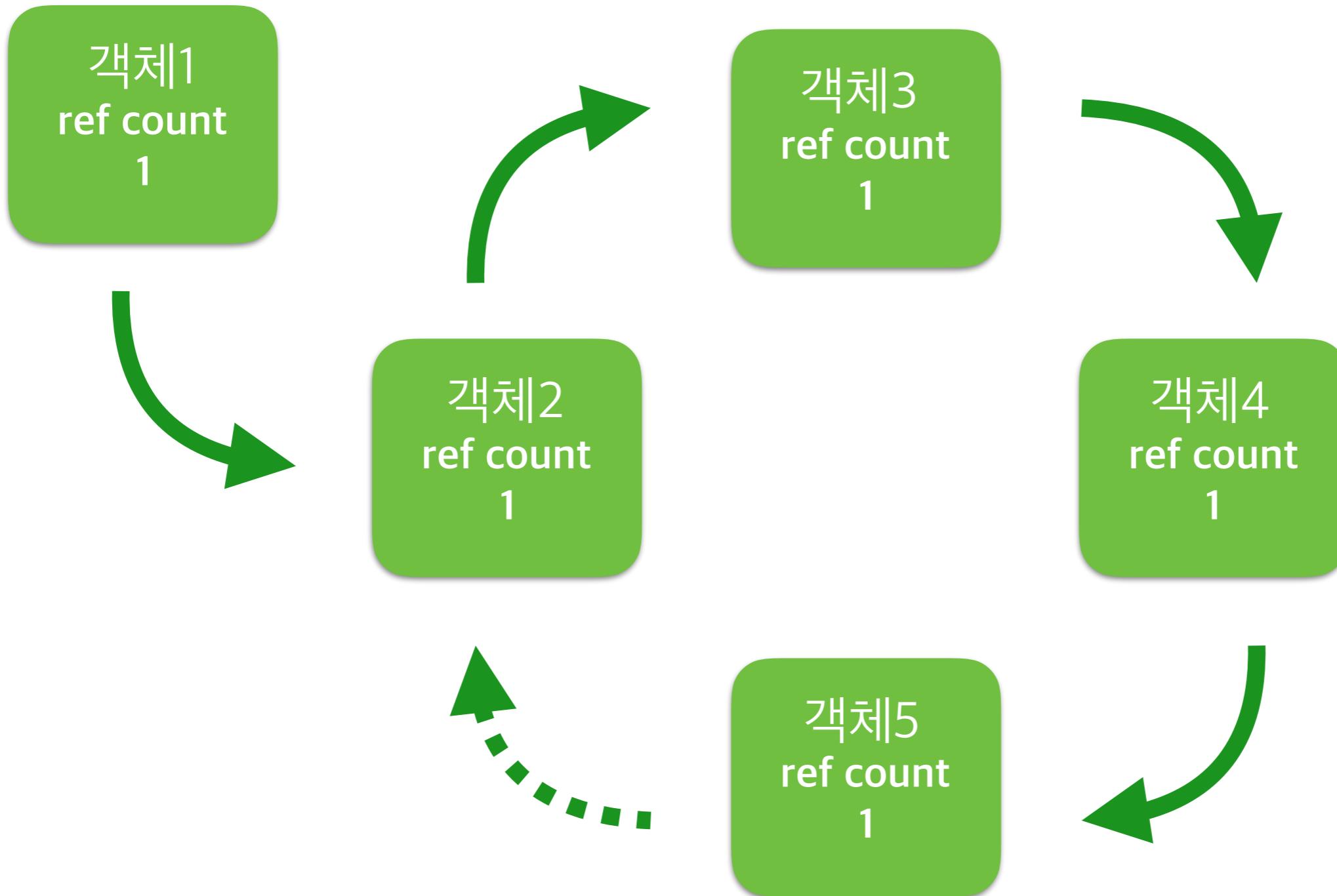
Strong Reference Cycle



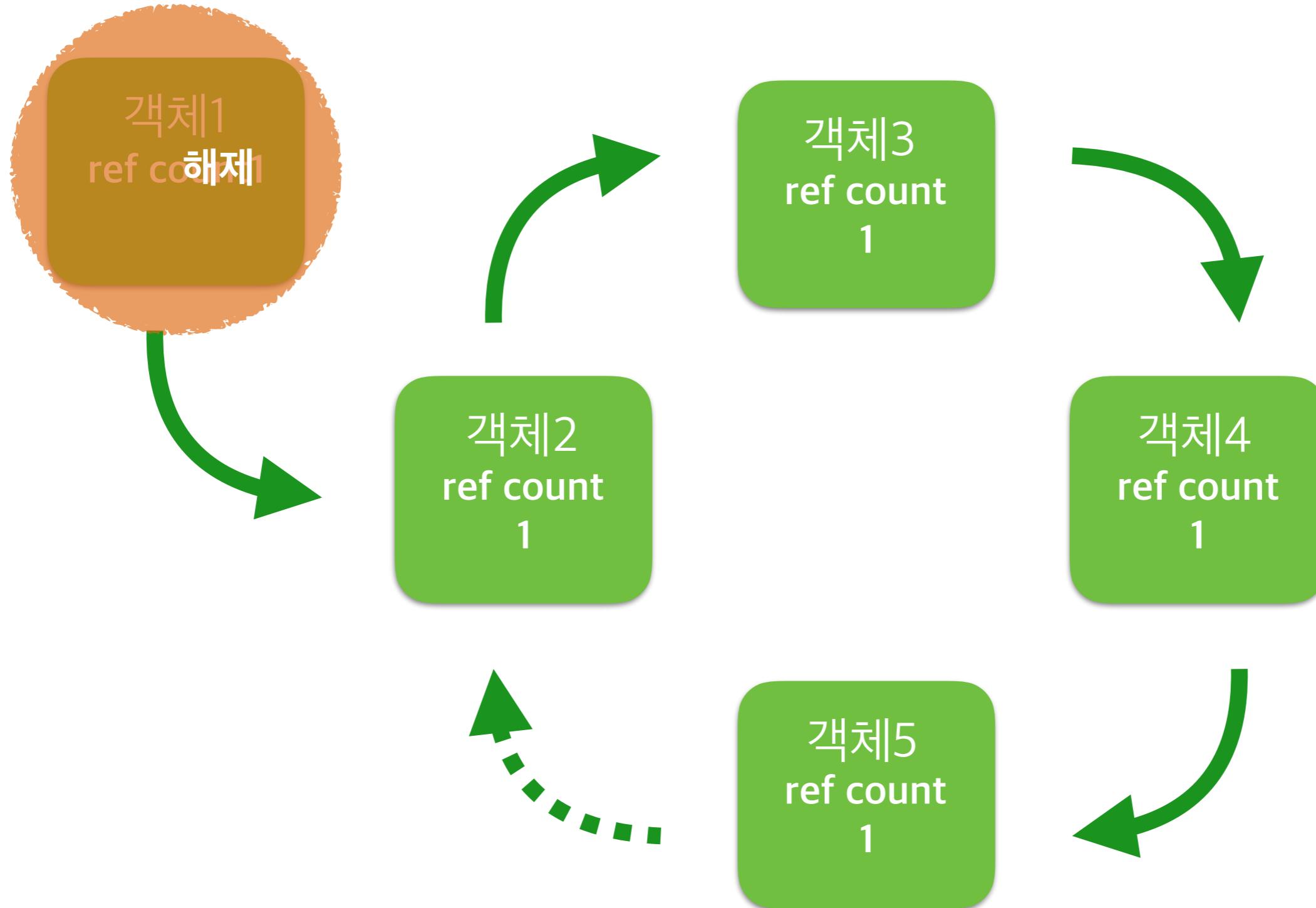
Weak Reference



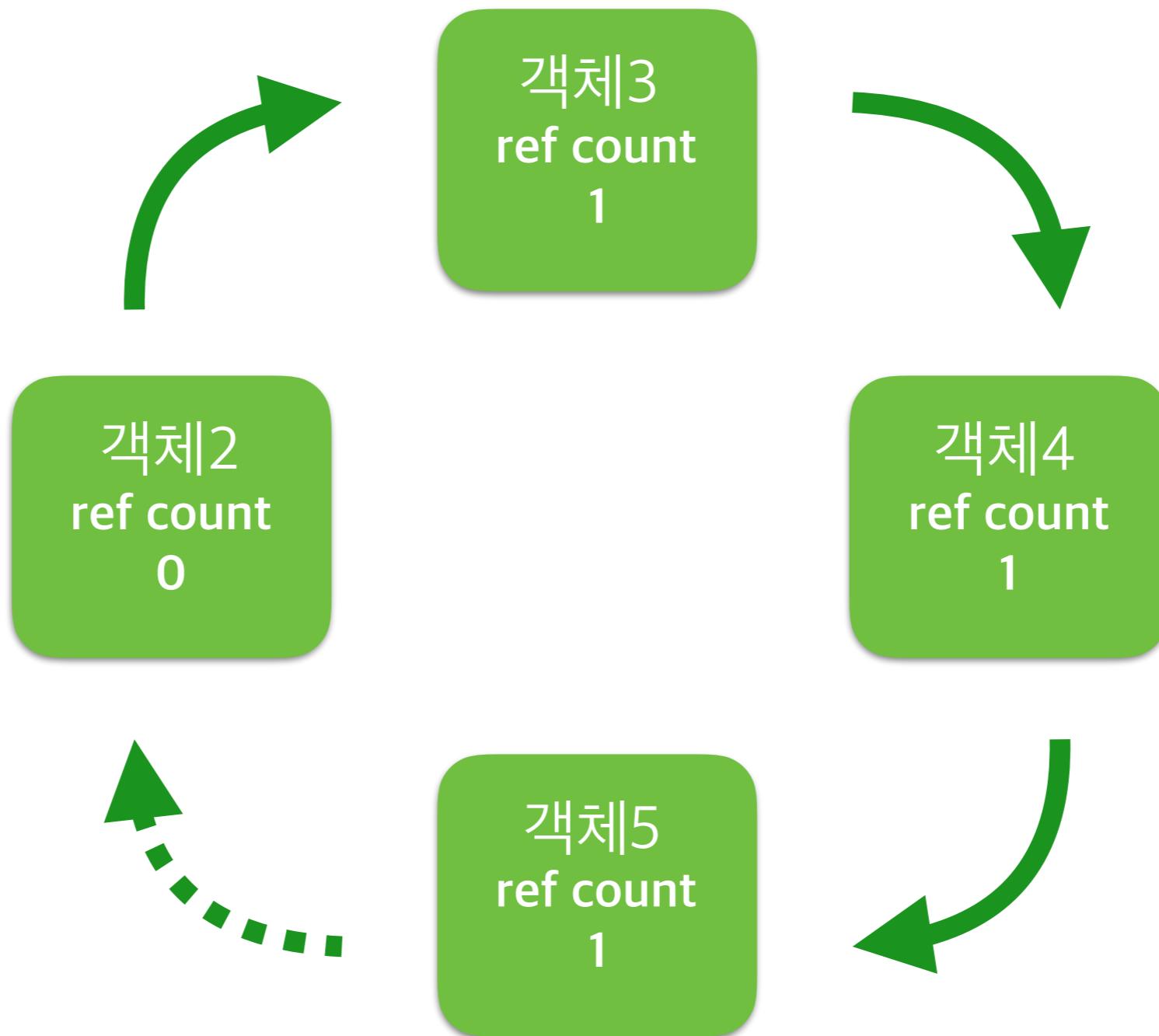
Weak Reference



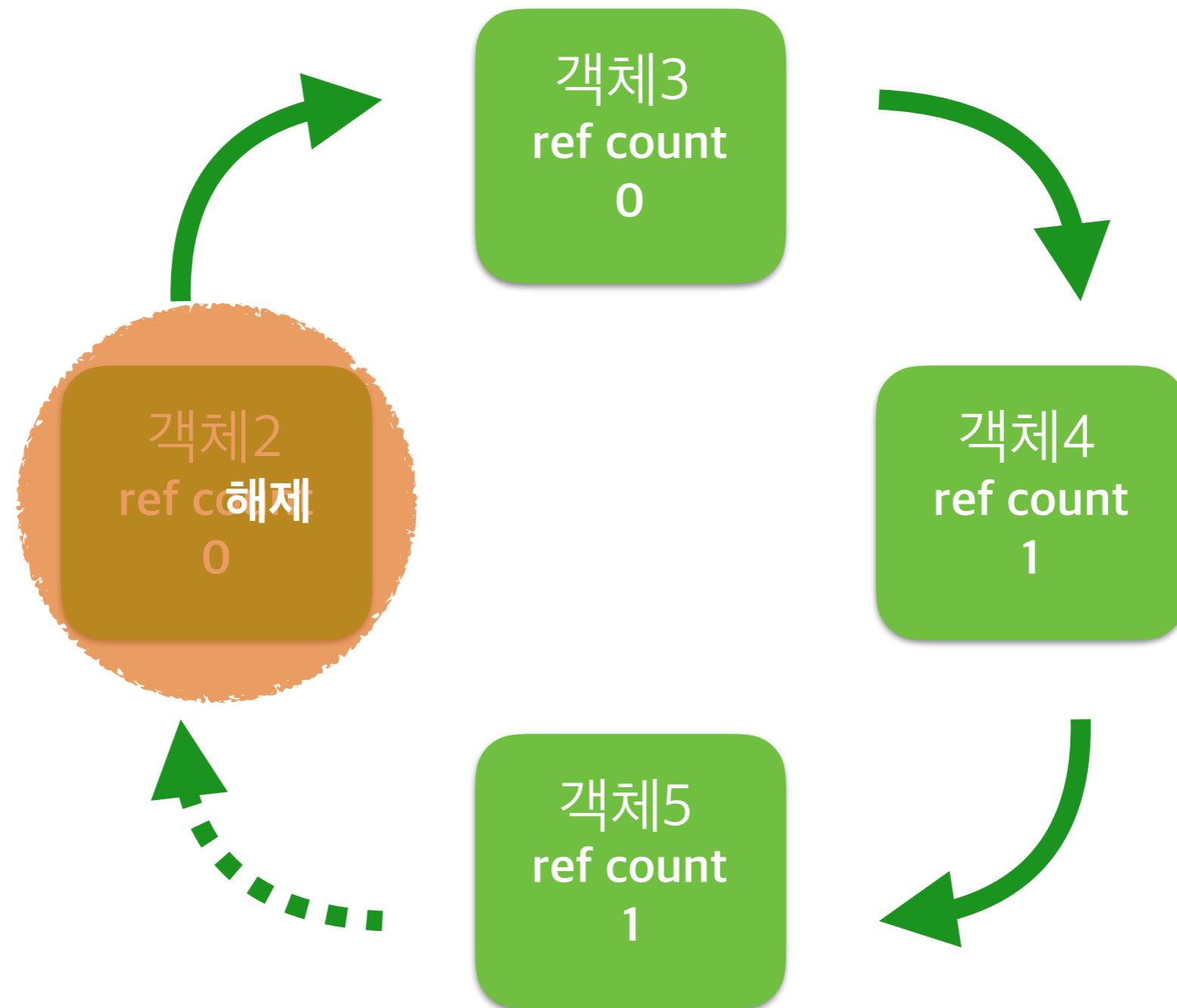
Weak Reference



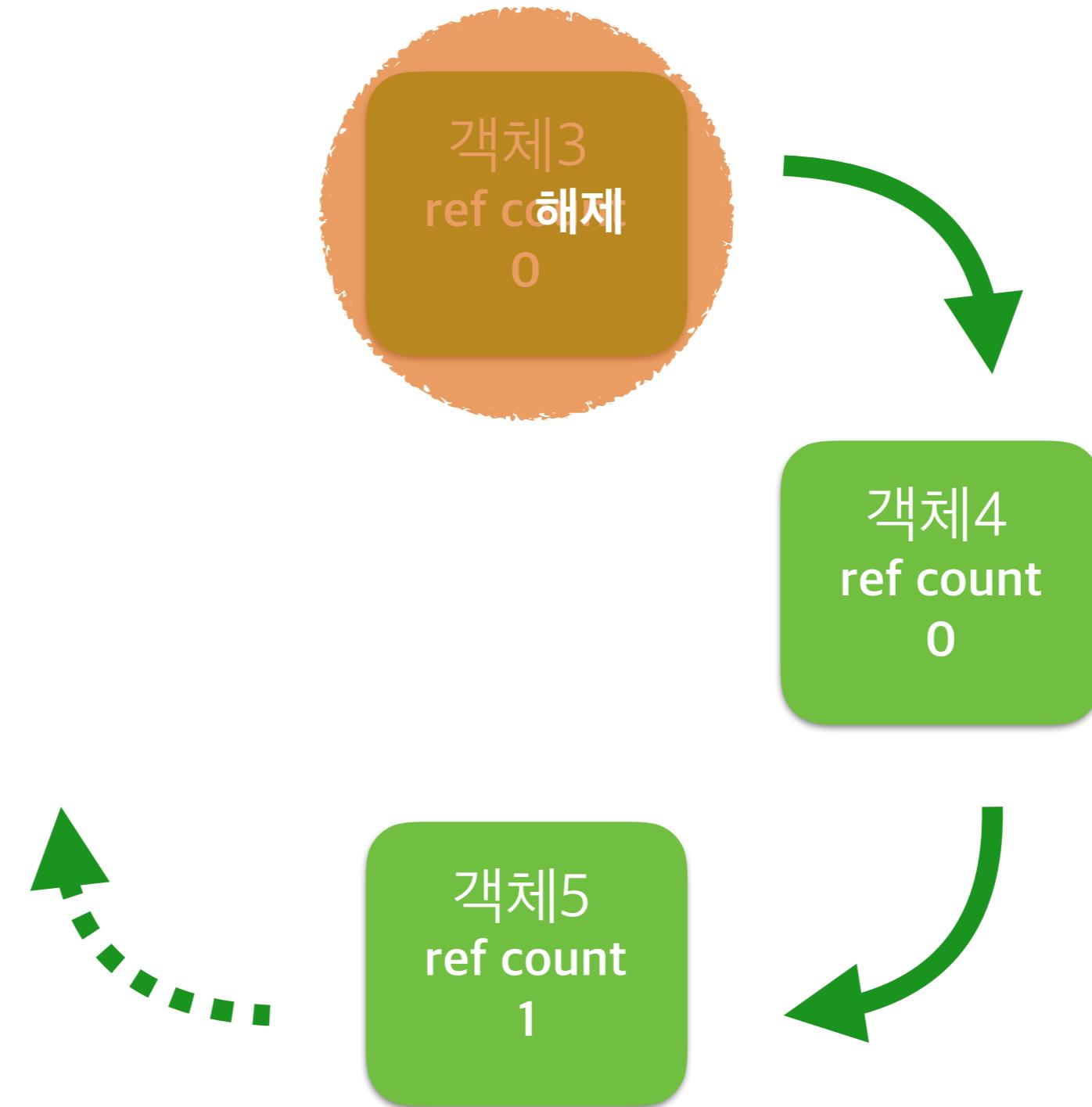
Weak Reference



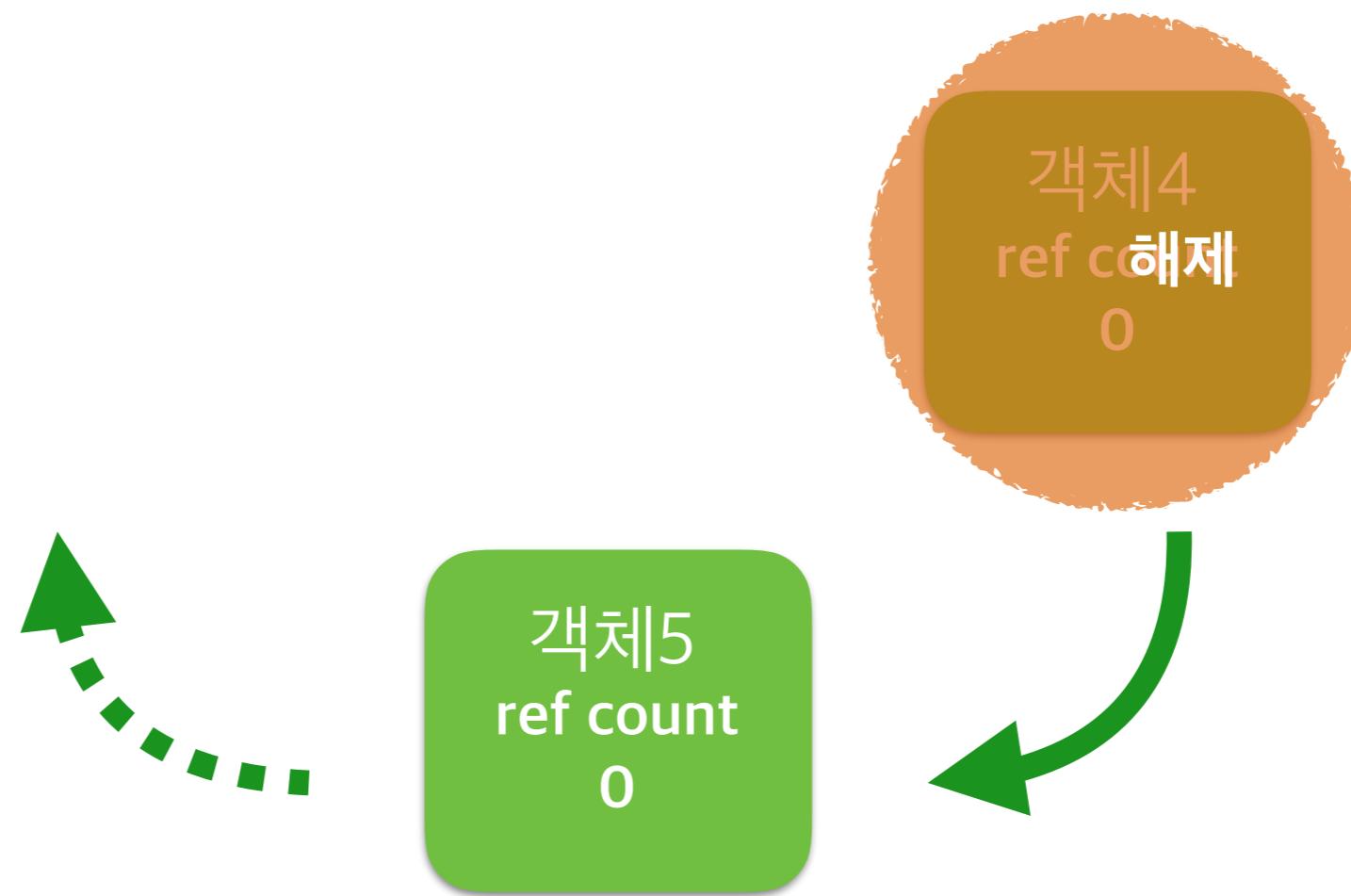
Strong Reference Cycle



Strong Reference Cycle



Strong Reference Cycle



Strong Reference Cycle

