# Using Swift and C++ for image processing

CocoaHeads Lviv ep. 5

Link to slides

# About me

https://www.goodreads.com/user/show/38693364-olha - add me to friends 🙂

Software engineer @ ADVA Soft

Some of the projects I've worked on:

HandyPhoto

TouchRetouch

Recrop

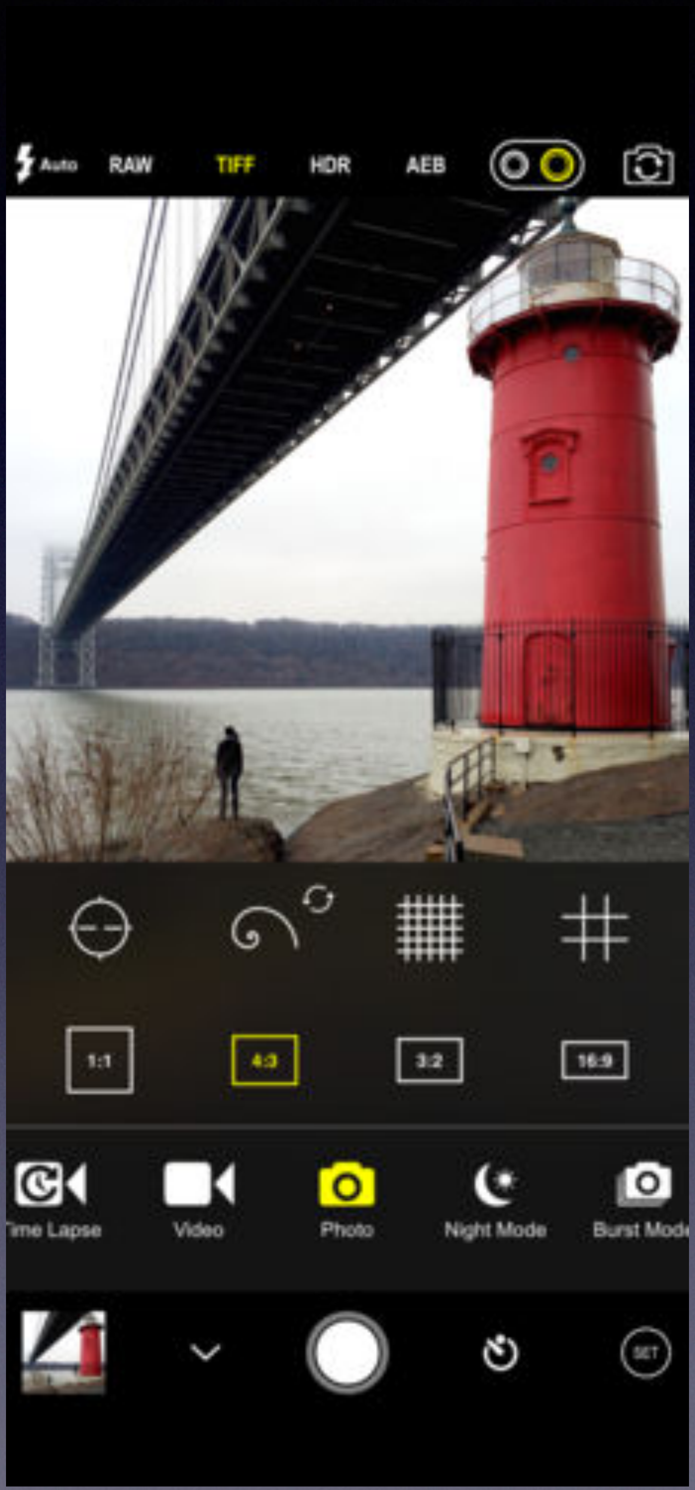
# Why integrate Swift and C++?

- cross-platform app (e.g. iOS/Android)
- nice library exists only in C++
- update Objc to Swift
- performance ( = unsafe 😀 )

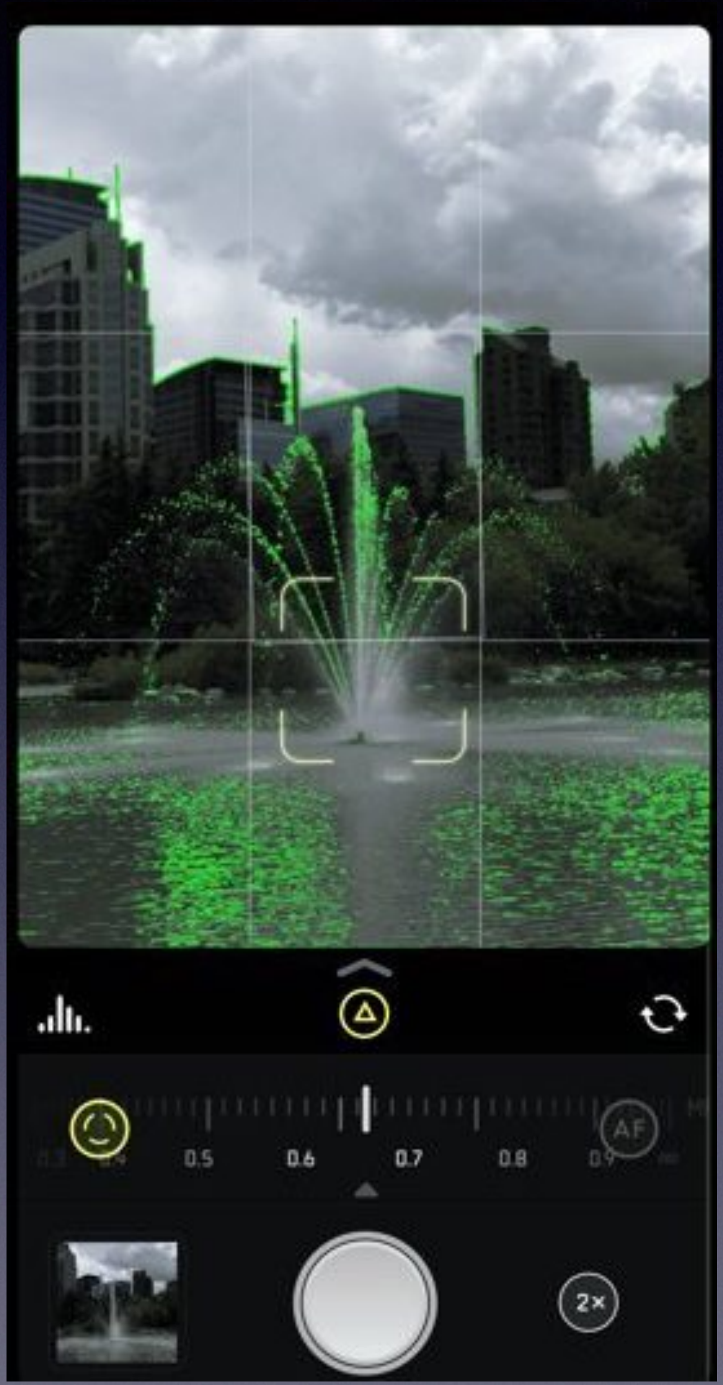
# Main challenges

- memory management
- interoperability issues: ObjC → Swift
- interoperability issues: Swift → ObjC

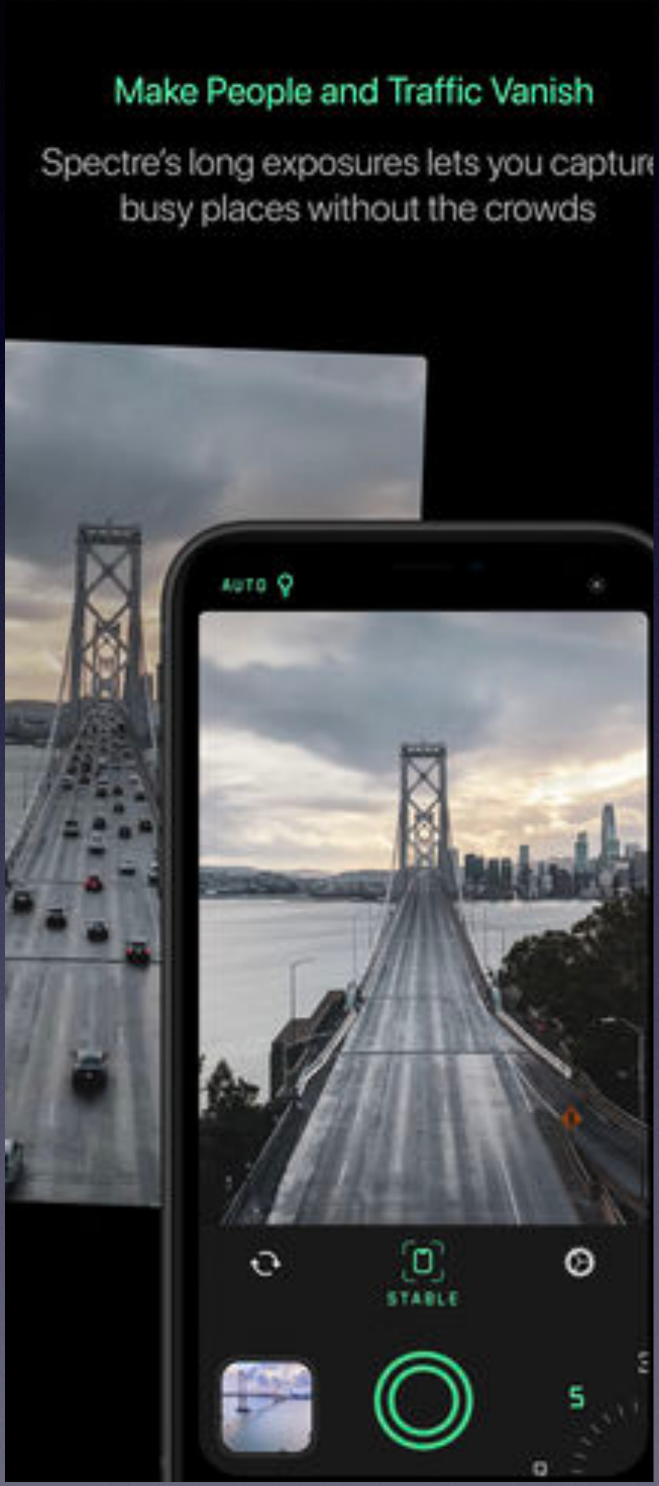
# Let’s build a custom camera



ProCam 6



Halide


Make People and Traffic Vanish

Spectre’s long exposures lets you capture busy places without the crowds

Spectre camera

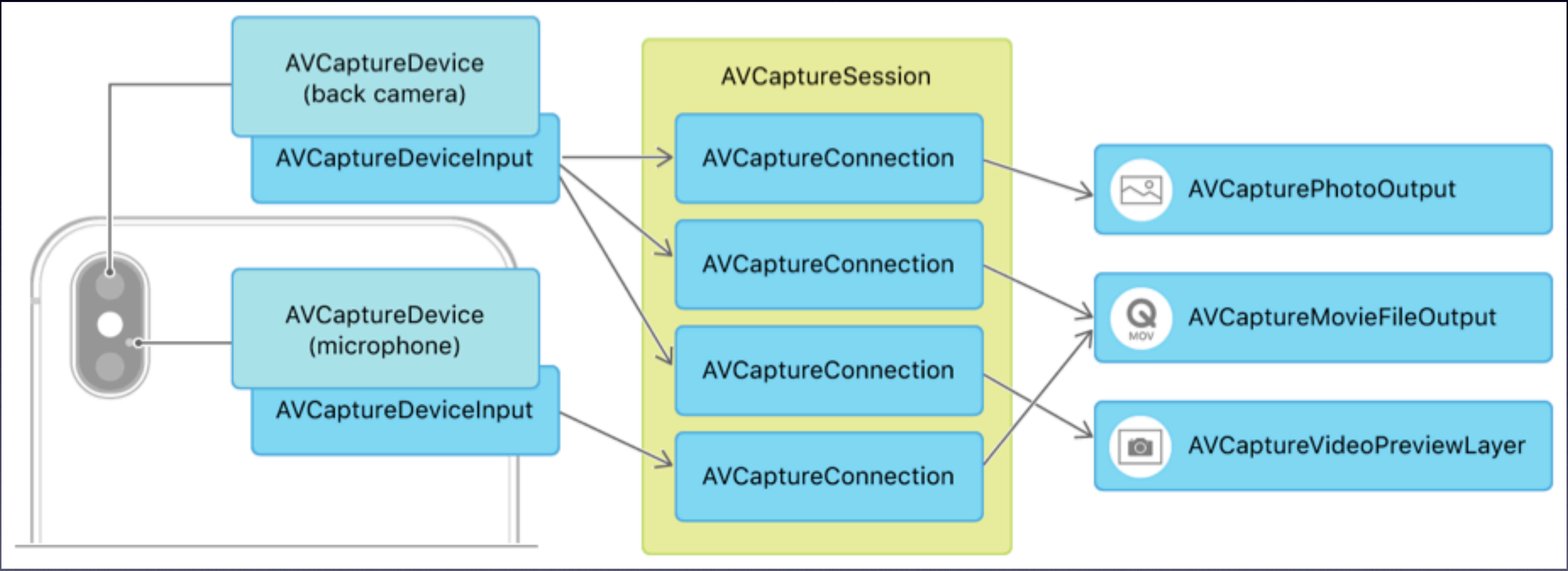
# What we'll do

receive video stream ( AVFoundation )

apply simple filter ( C++ )

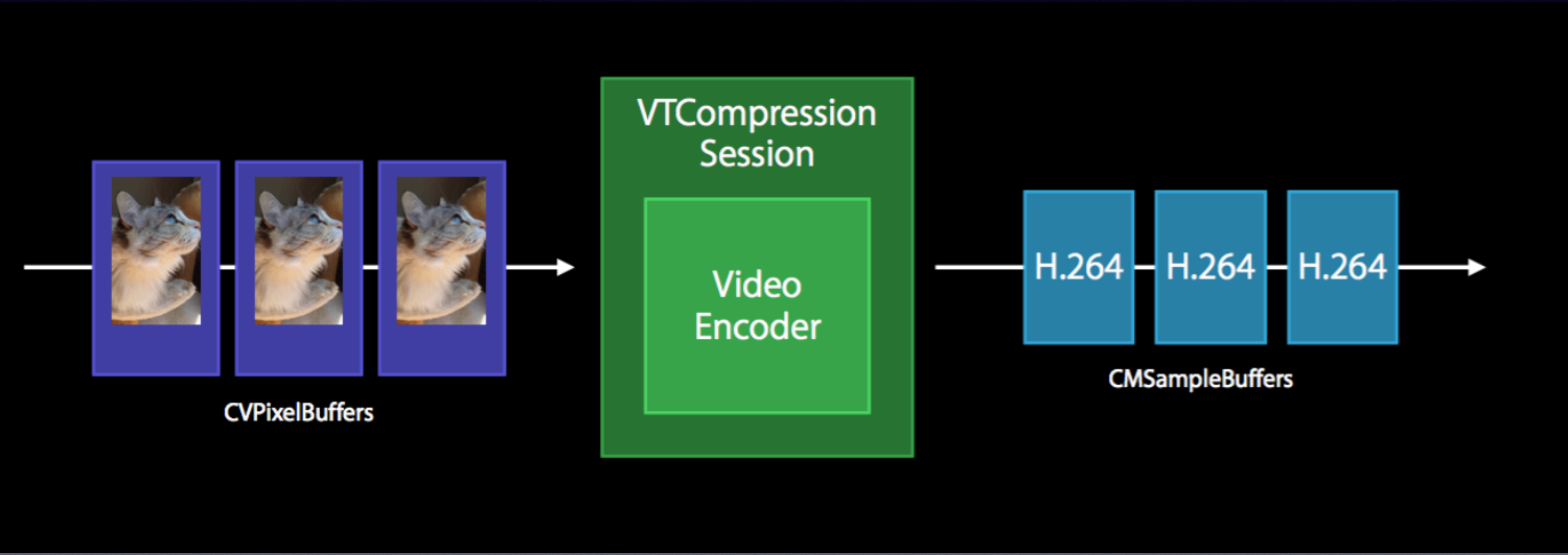
detect edges ( OpenCV )

# AVFoundation: input & output



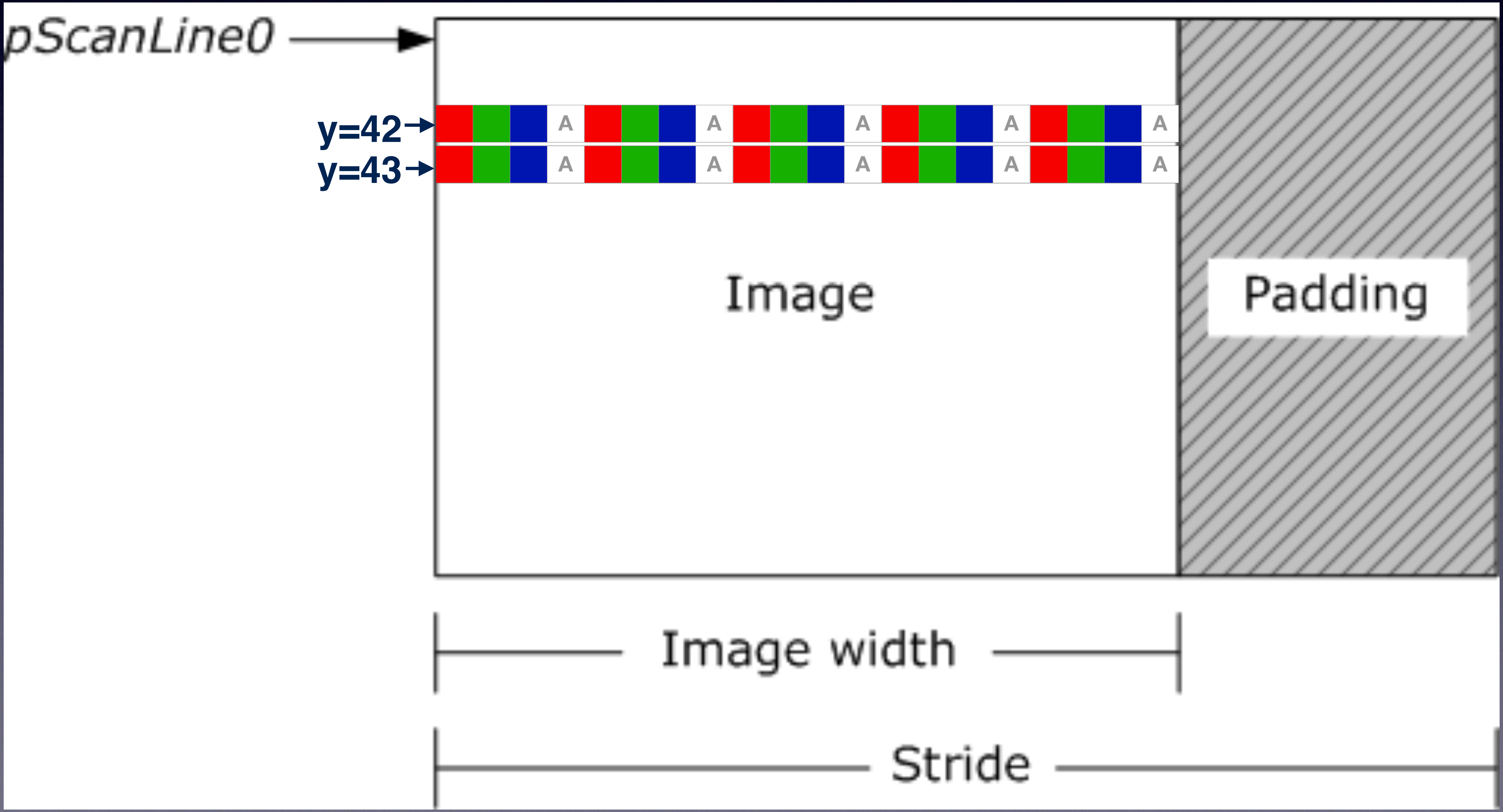
```
class AVSampleBufferDisplayLayer : CALayer
```

# AVFoundation: CVPixelBuffer



# CVPixelBuffer memory layout

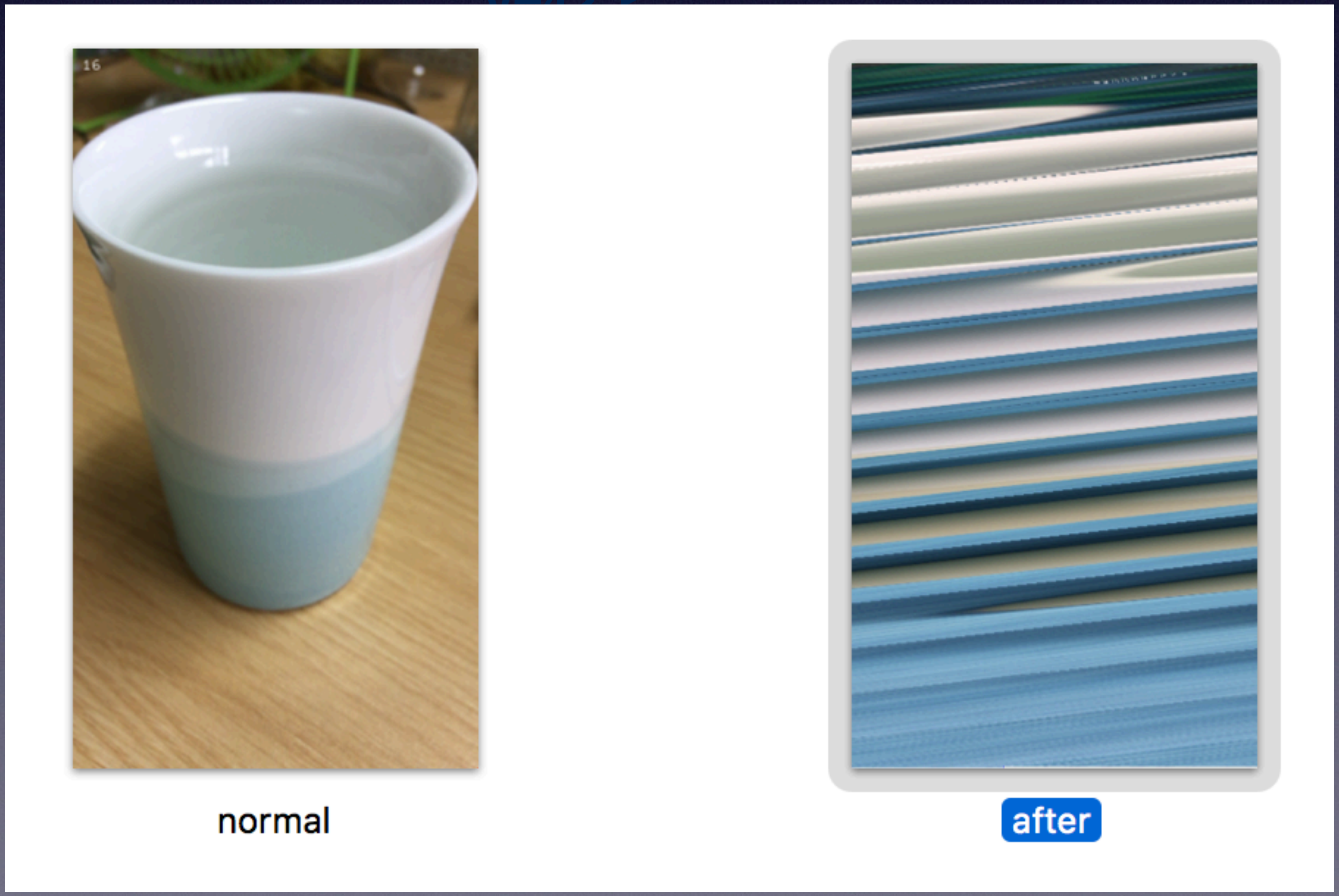
**BGRA**: each pixel takes 4 bytes = 32 bits



# CVPixelBuffer memory layout

**Line padding** = more efficient processing (SSE/MMX)

Accelerate.framework: vImage, vDSP

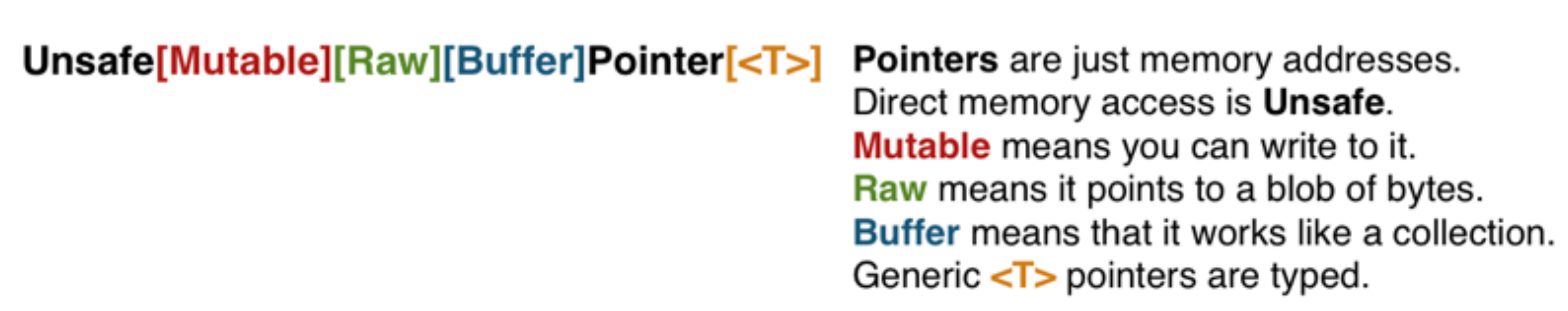


the **stride** was ignored

# Example #0: simple filter

## **UnsafePointer**:

- interoperability
- building high performance data structures



**Unsafe[Mutable][Raw][Buffer]Pointer[<T>]**

**Pointers** are just memory addresses.
Direct memory access is **Unsafe**.
**Mutable** means you can write to it.
**Raw** means it points to a blob of bytes.
**Buffer** means that it works like a collection.
Generic **<T>** pointers are typed.

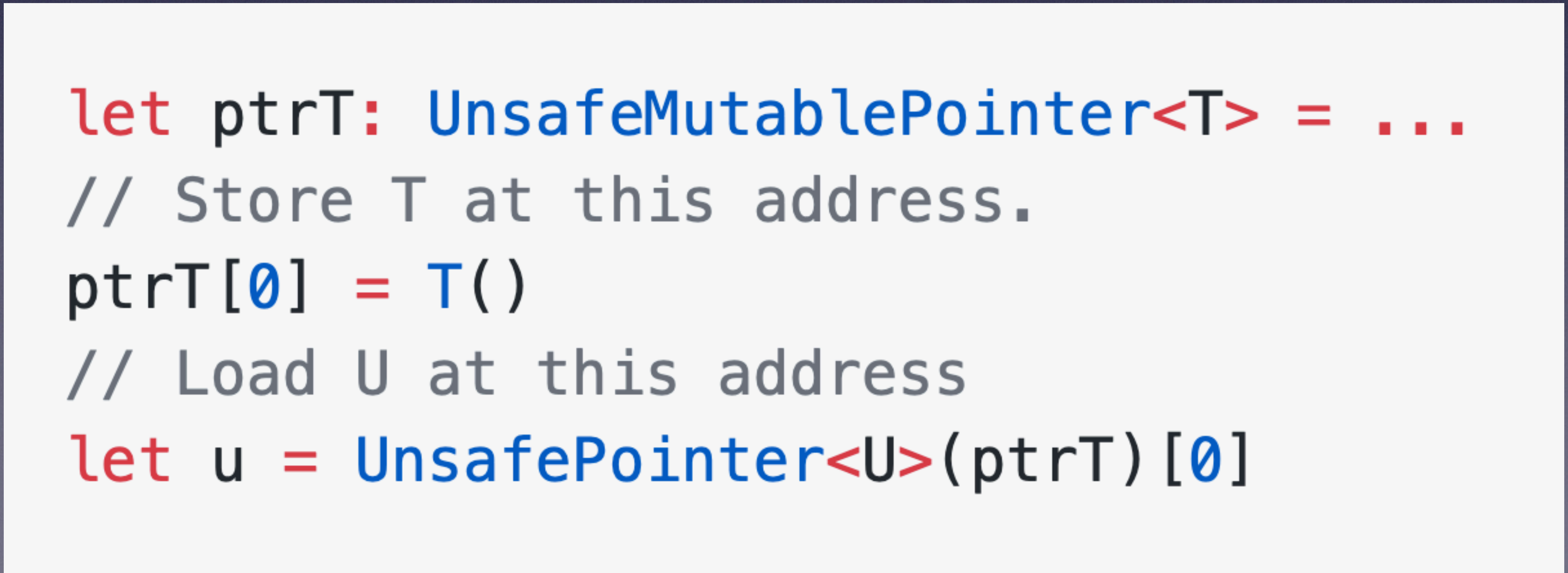
# Example #0: simple filter

Why not just cast them?

```
UnsafeMutableRawPointer = void*
```

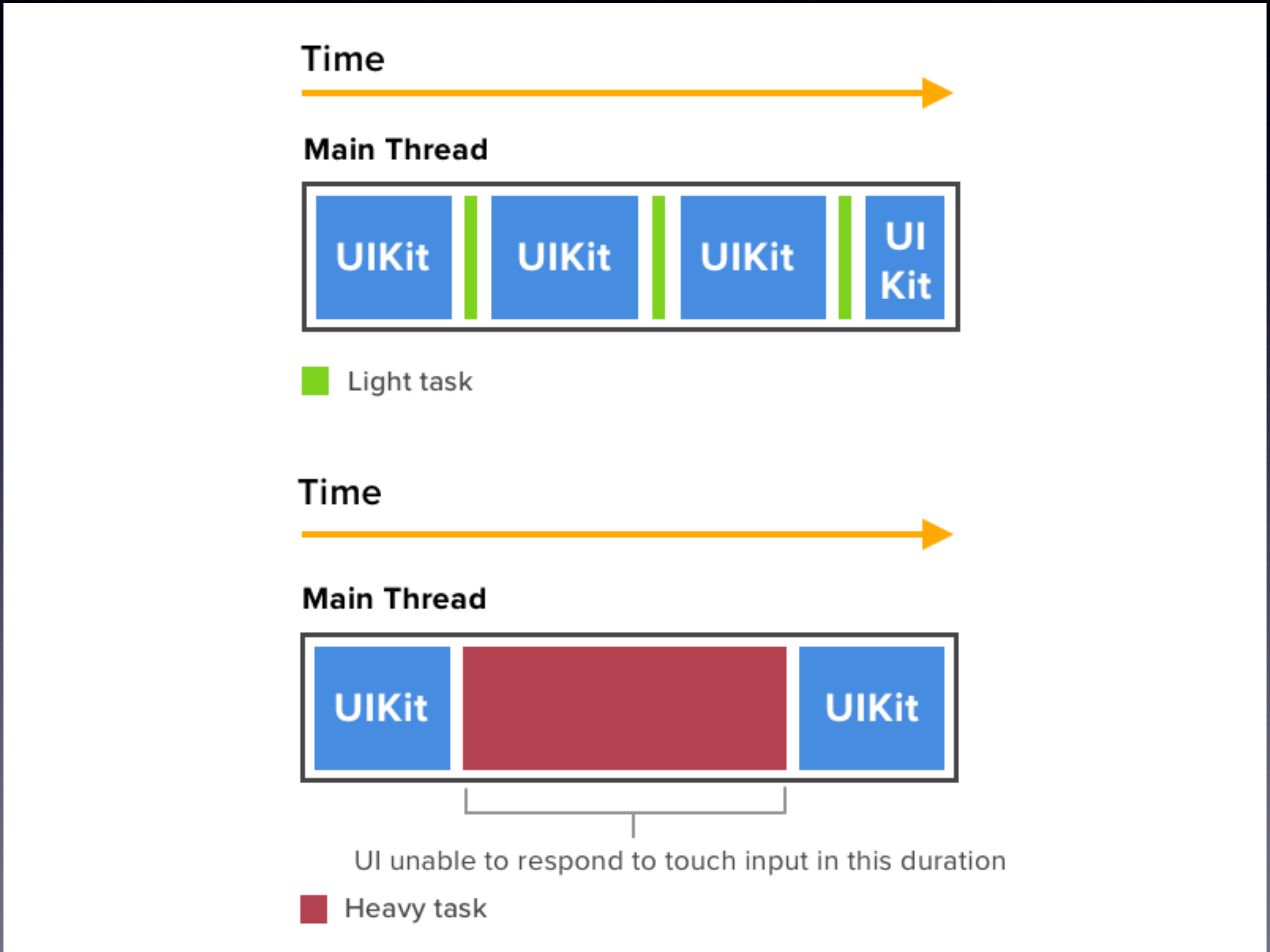
```
UnsafeMutablePointer<Uint8> = unsigned char*
```

Type punning: undefined behavior 😅



```
let ptrT: UnsafeMutablePointer<T> = ...
// Store T at this address.
ptrT[0] = T()
// Load U at this address
let u = UnsafePointer<U>(ptrT)[0]
```

# Example #1: slow operation on Main thread

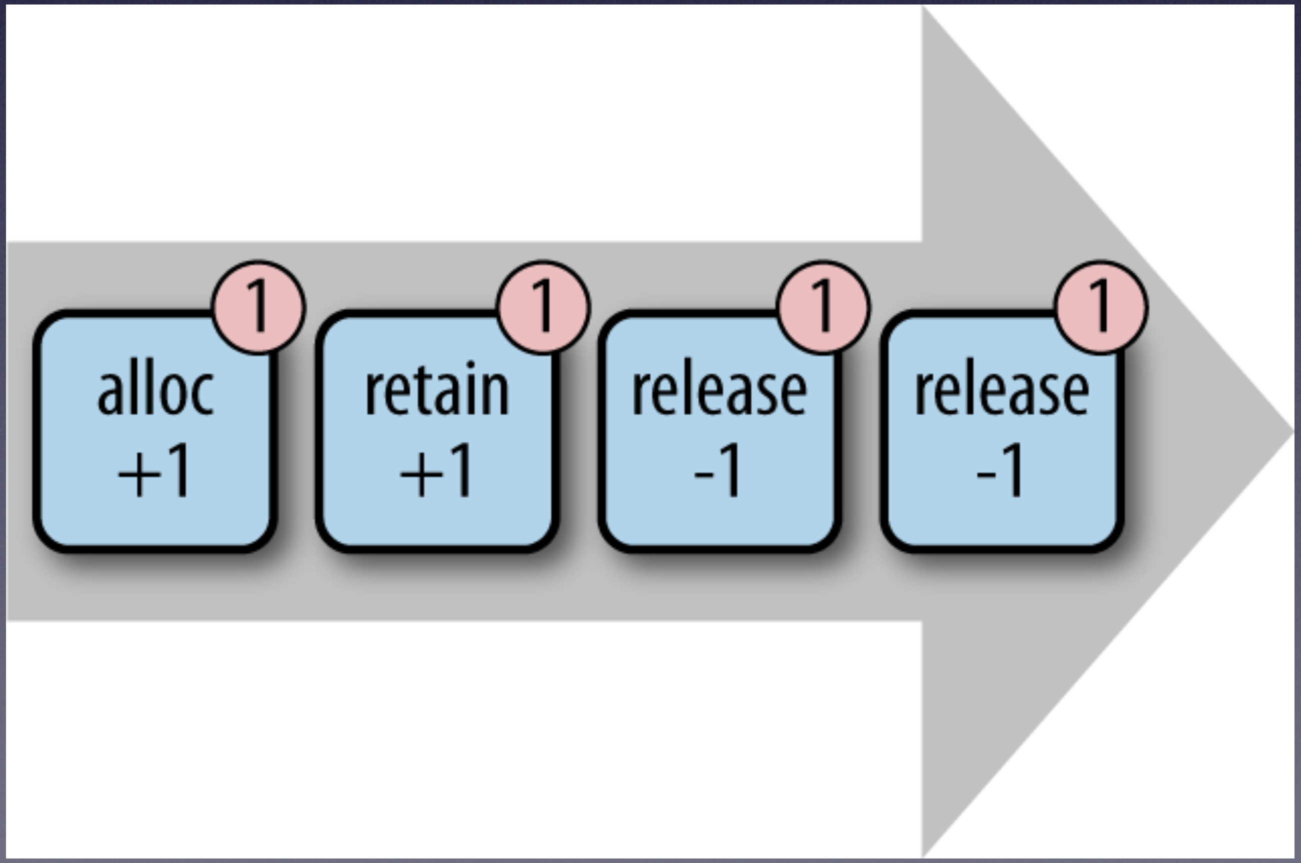


# Example #2: Dispatch algorithm to background thread

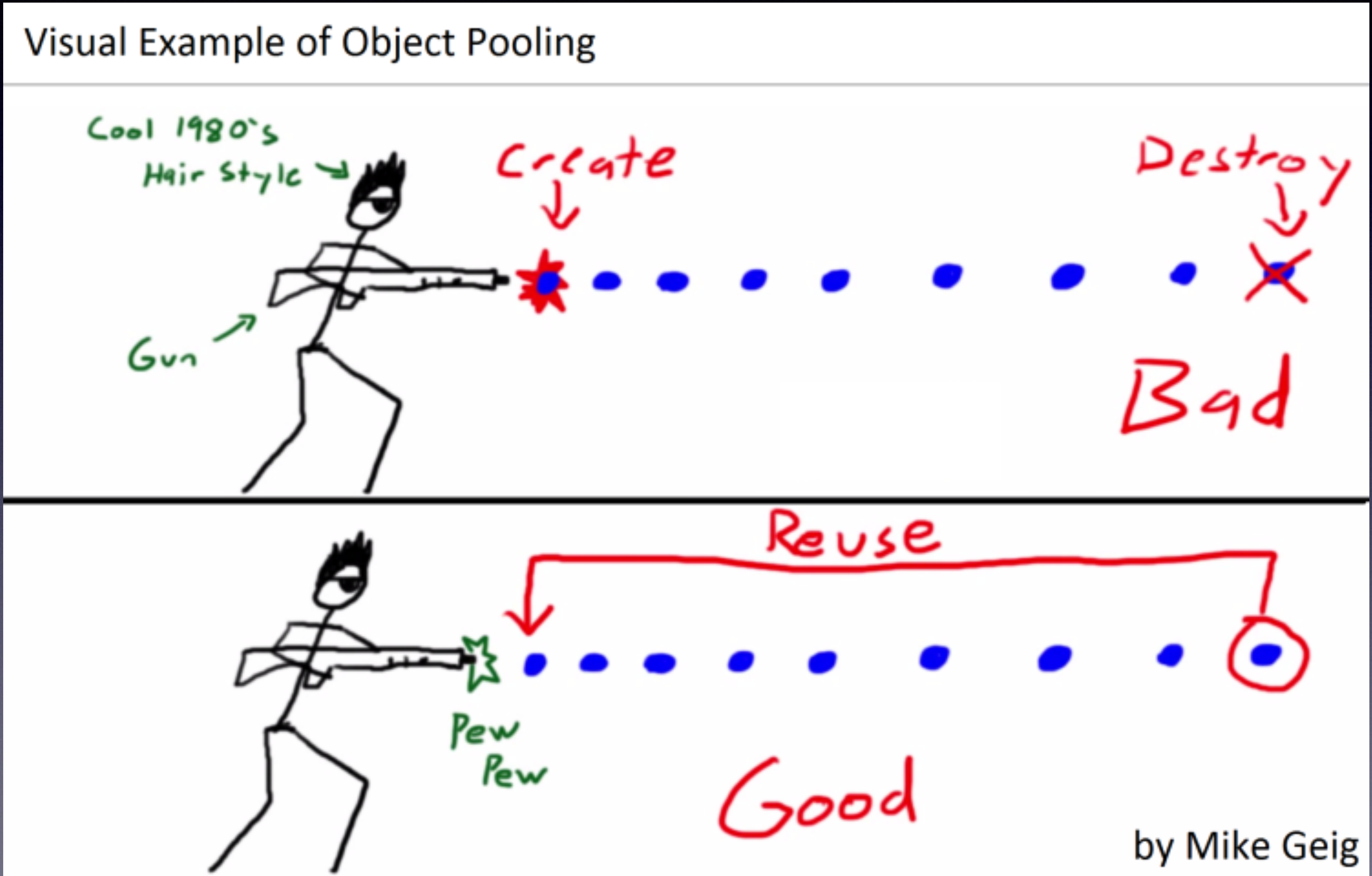
C++ **object allocation**: stack vs heap

**Unmanaged**:

- takeRetainedValue
- takeUnretainedValue
- toOpaque, fromOpaque
- passRetained
- passUnretained



# Example #2: Retain
# ( Spoiler 😶 )



by Mike Geig

# Example #3: Copy PixelBuffer
# ( when we need a few of them )

**ARC != CoreFoundation memory management**

we are responsible for CFRetain/CFRelease/malloc/…

# Questions?

## References

- https://www.raywenderlich.com/780-unsafe-swift-using-pointers-and-interacting-with-c
- https://github.com/apple/swift-evolution/blob/master/proposals/0107-unsaferawpointer.md
- https://nshipster.com/unmanaged/
- https://developer.apple.com/documentation/accelerate/vimage/applying_vimage_operations_to_video_sample_buffers

## Feedback 🙏

https://forms.gle/yc5tDDy7xFw9DSXw7