How to Write a Swift Macro

without going (too much) down the rabbit hole

Vincent Pradeilles 🇫🇷 (@v_pradeilles) – PhotoRoom

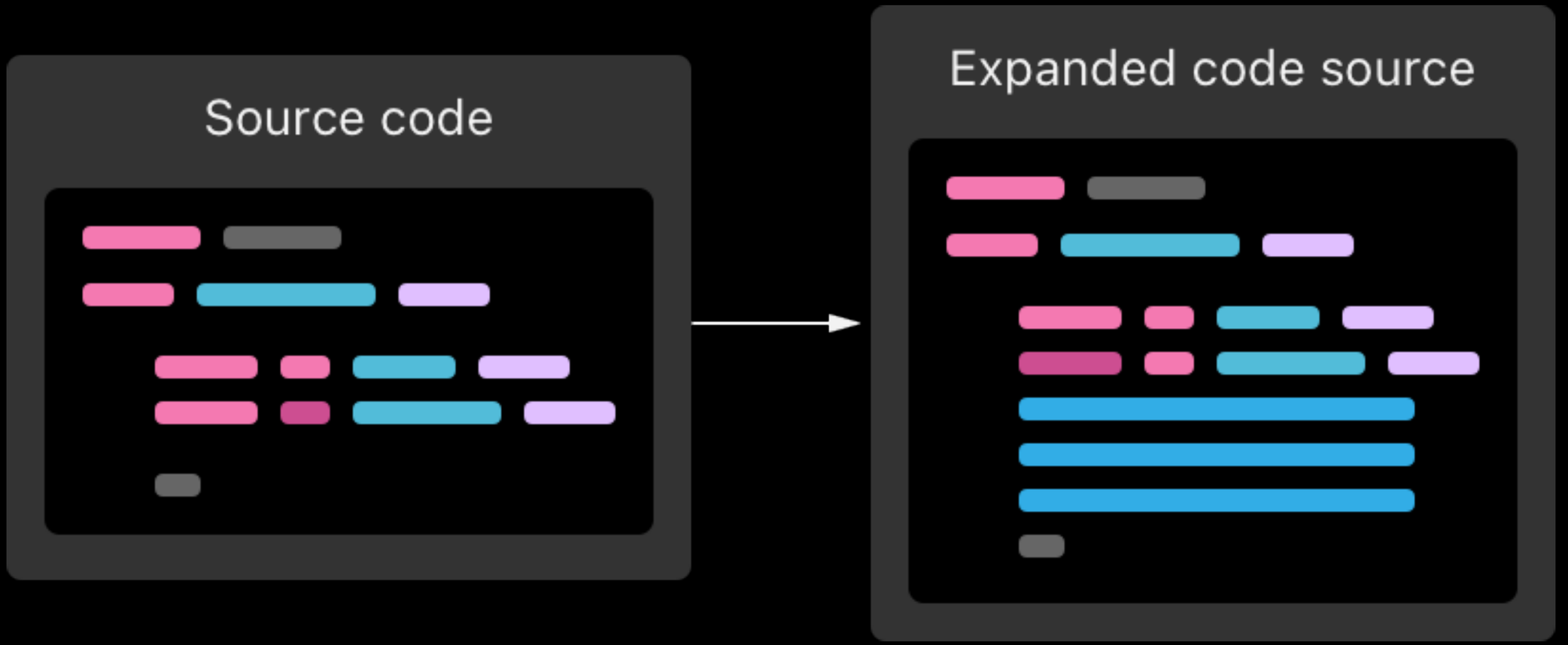
Let’s start with the bad news…

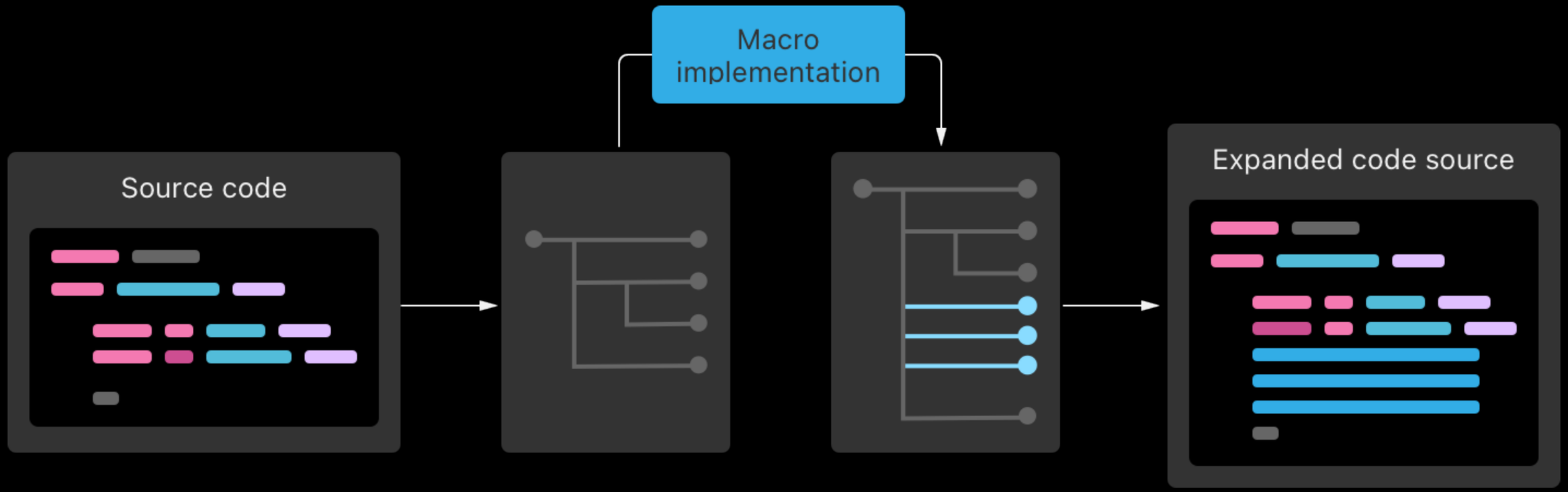
…Swift macros are hard!

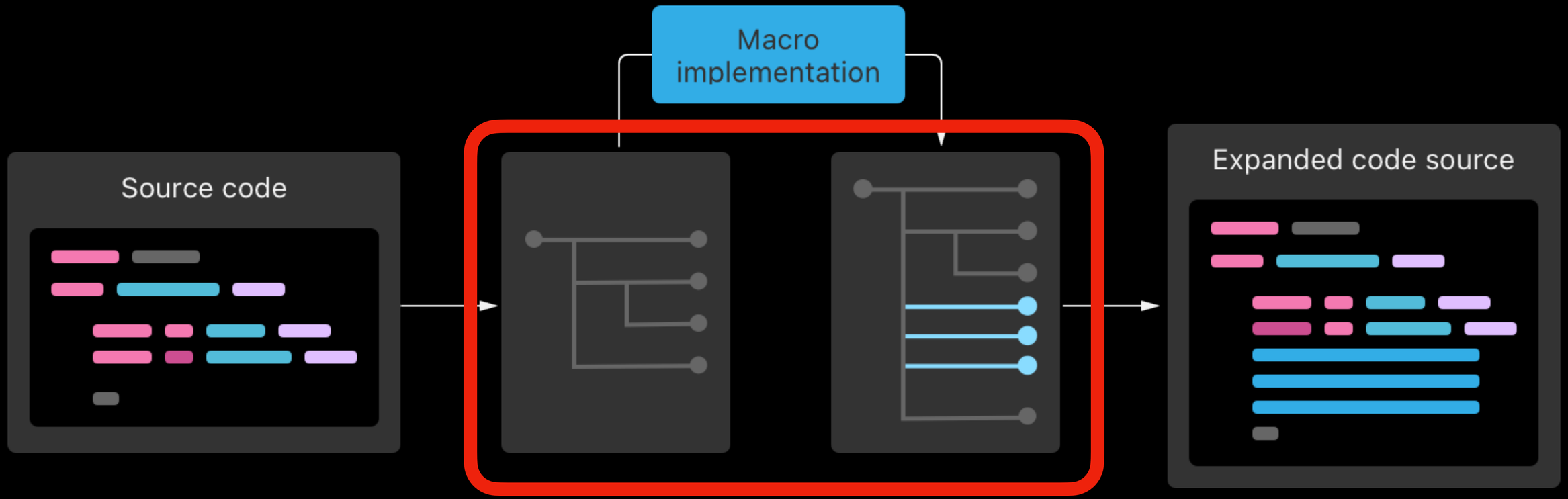
And there’s no way around it 😔

Why are macros that hard? 🤨

Let’s deep dive on how macros work!


Source code
Expanded code source


Macro implementation
Source code
Expanded code source


Macro
implementation
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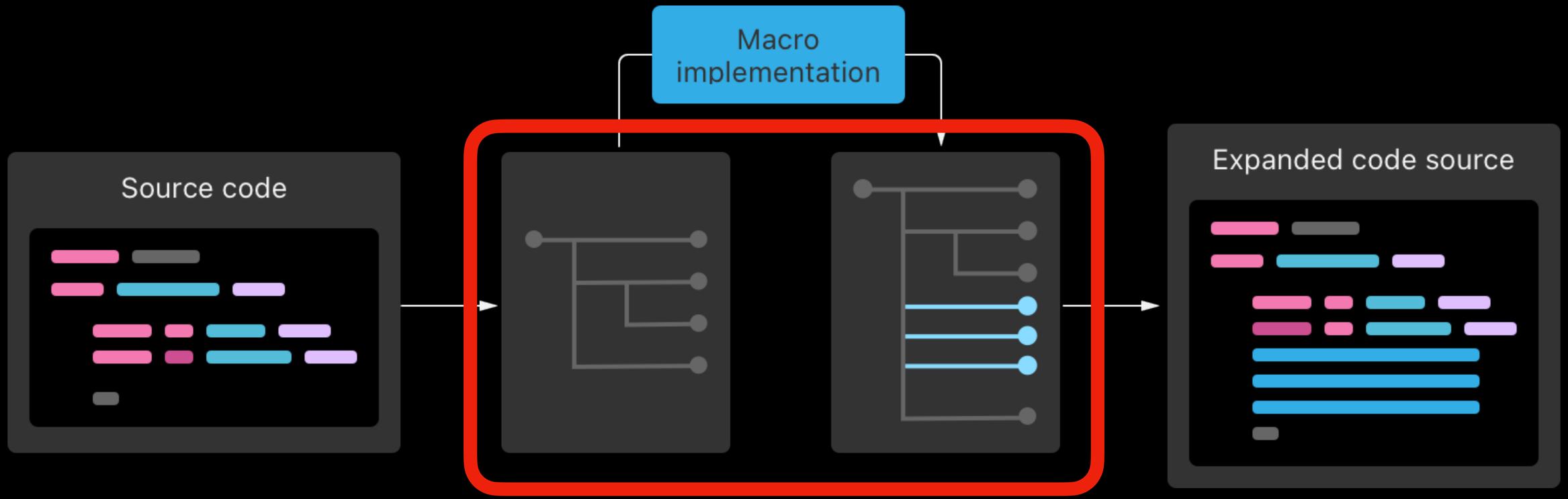
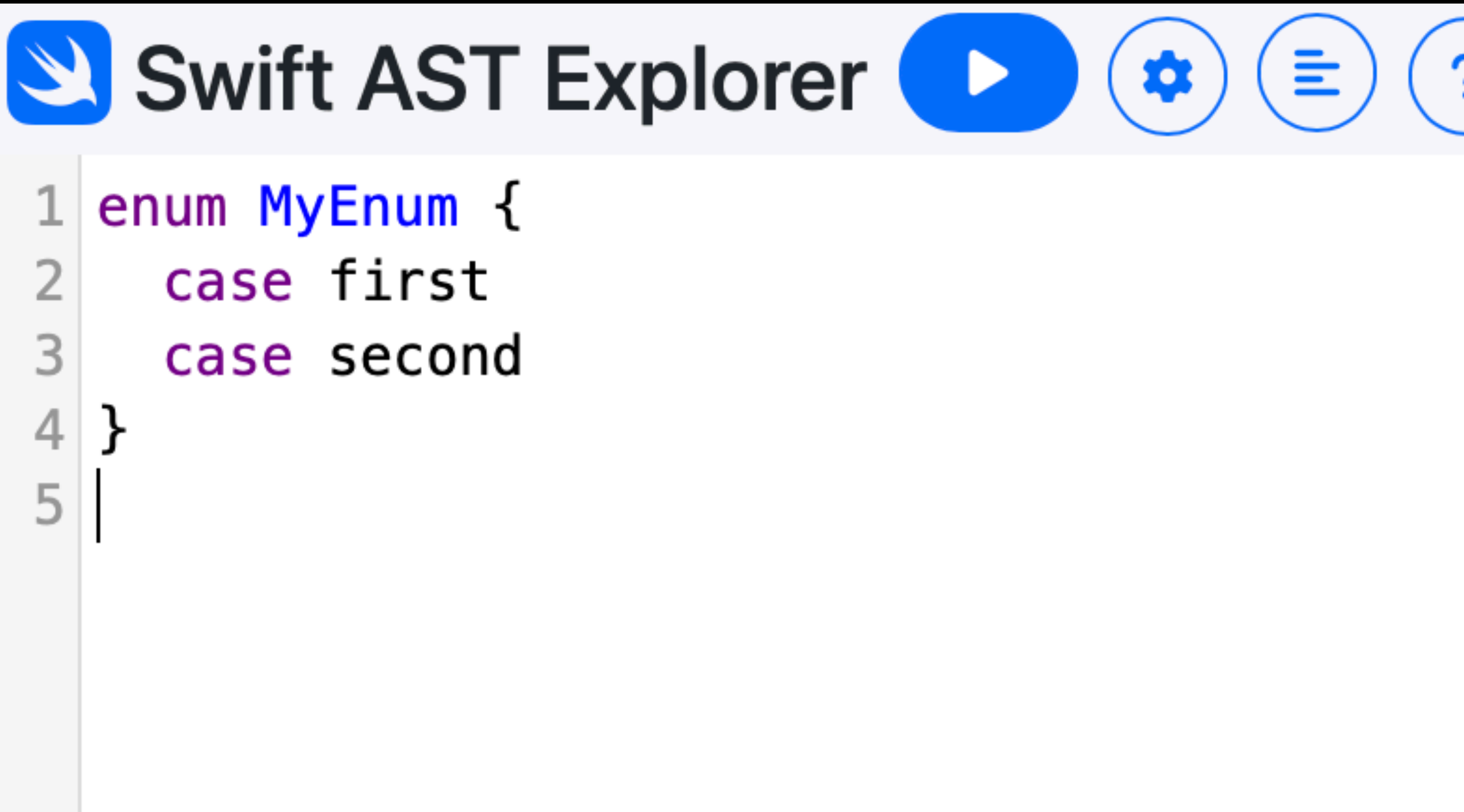
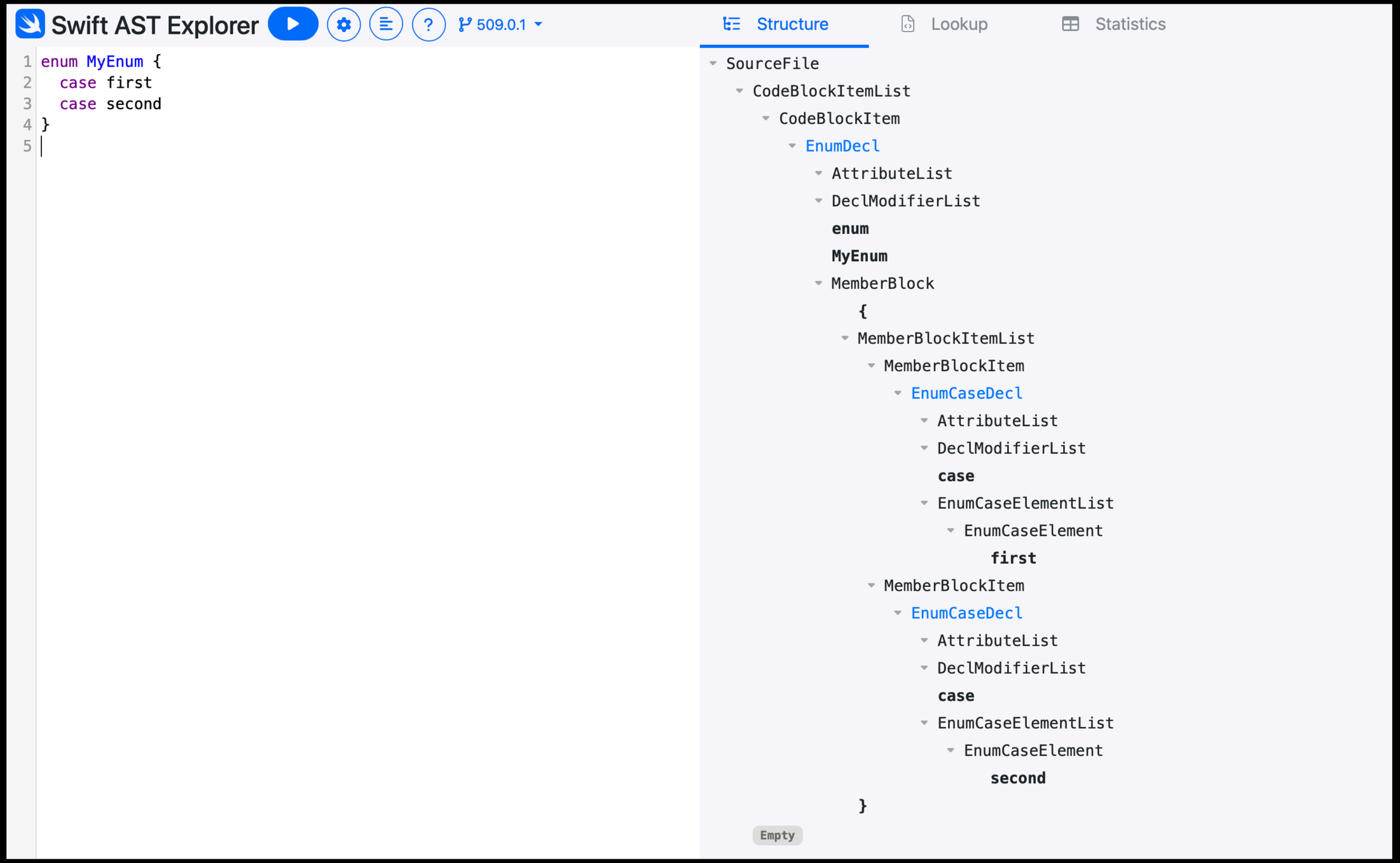


Abstract Syntax Tree (or AST)


Swift AST Explorer
1 enum MyEnum {
2 case first
3 case second
4 }
5


Swift AST Explorer
509.0.1
Structure
Lookup
Statistics
1 enum MyEnum {
2 case first
3 case second
4 }
5
SourceFile
CodeBlockItemList
CodeBlockItem
EnumDecl
AttributeList
DeclModifierList
enum
MyEnum
MemberBlock
{
MemberBlockItemList
MemberBlockItem
EnumCaseDecl
AttributeList
DeclModifierList
case
EnumCaseElementList
EnumCaseElement
first
MemberBlockItem
EnumCaseDecl
AttributeList
DeclModifierList
case
EnumCaseElementList
EnumCaseElement
second
}
Empty

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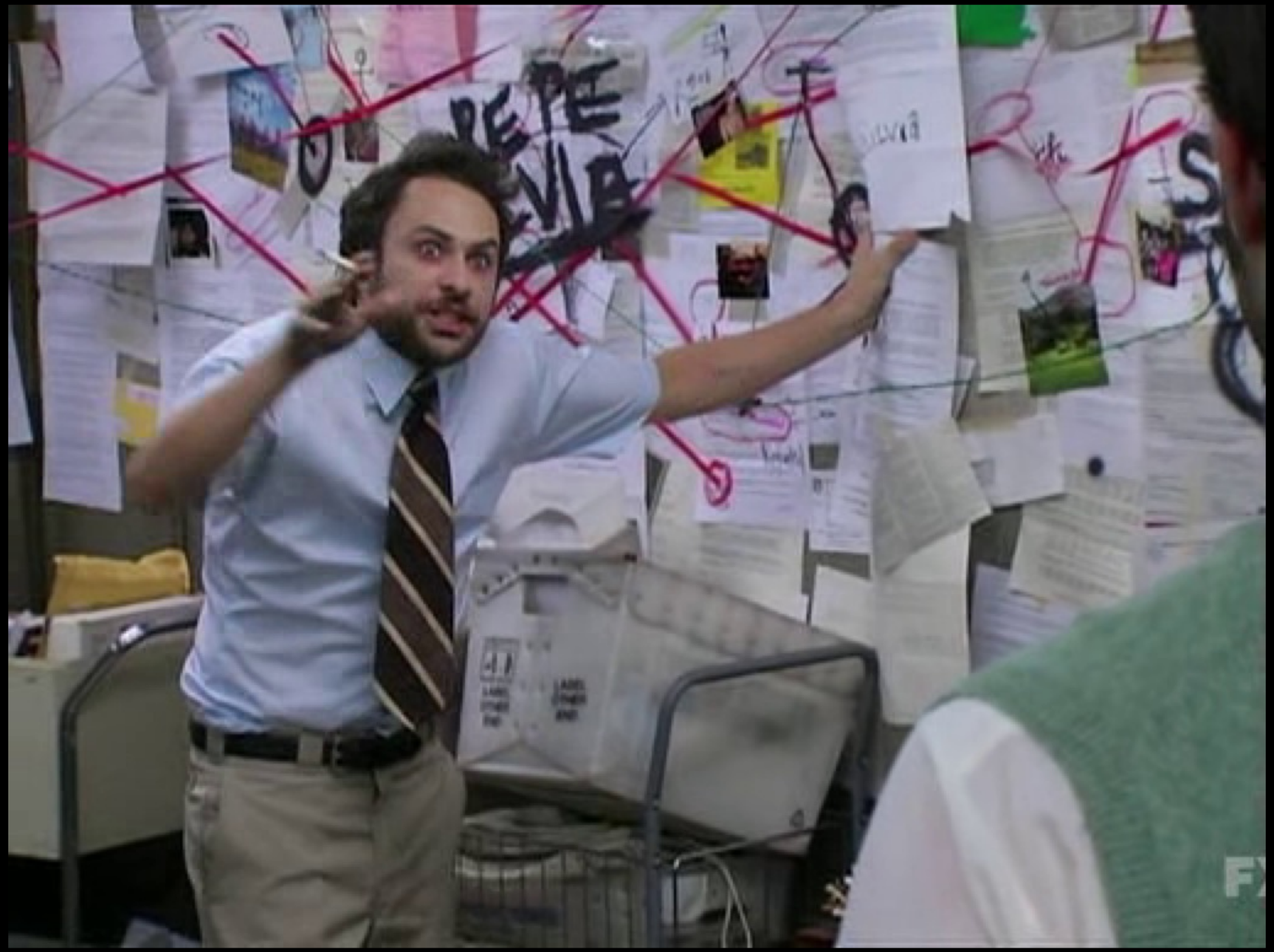
- Big picture: a macro takes a portion of the AST as its input…
- …and expands it into a new AST
- The AST is a complex structure…
- …and handling it is fundamentally different than writing app-level code
- And that’s the main reason why macros are hard!

This means that a talk about building macros is likely to feel like this:



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So here’s what we’re going to do

- I made a selection of macros that have been implemented by the community
- We’ll go over how to use them and how they’ve been implemented
- This way you’re going to discover macros that are ready-to-use…
- …and you’ll also have some pointers on how to implement or customize macros, should you need to!

#01 – #URL(_:)

https://github.com/apple/swift-syntax/tree/main/Examples/Sources/MacroExamples

```
import Foundation

let goodUrl = #URL("https://www.apple.com")

let badUrl = #URL("https://www.ap   ple.com")
```

```
import Foundation

let goodUrl = #URL("https://www.apple.com")
URL(string: "https://www.apple.com")!                    #URL

let badUrl = #URL("https://www.ap    ple.com")   M...
```

Malformed url: "https://www.ap ple.com"

Now let’s see the implementation

```
/// Check if provided string literal is a valid URL and
produce a non-optional
/// URL value. Emit error otherwise.
@freestanding(expression)
public macro URL(
    _ stringLiteral: String
) -> URL = #externalMacro(
    module: "MyMacroMacros",
    type: "URLMacro"
)
```

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    _ stringLiteral: String
) -> URL = #externalMacro(
    module: "MyMacroMacros",
    type: "URLMacro"
)
```

```swift
public enum URLMacro: ExpressionMacro {
  public static func expansion(
    of node: some FreestandingMacroExpansionSyntax,
    in context: some MacroExpansionContext
  ) throws -> ExprSyntax {
    // 1. Parsing the AST
    guard let argument = node.argumentList.first?.expression,
      let segments = argument.as(StringLiteralExprSyntax.self)?.segments,
      segments.count == 1,
      case .stringSegment(let literalSegment)? = segments.first
    else {
      throw CustomError.message("#URL requires a static string literal")
    }

    // 2. Running the macro's logic
    guard let _ = URL(string: literalSegment.content.text) else {
      throw CustomError.message("malformed url: \(argument)")
    }

    // 3. Returning a new AST
    return "URL(string: \(argument))!"
  }
}
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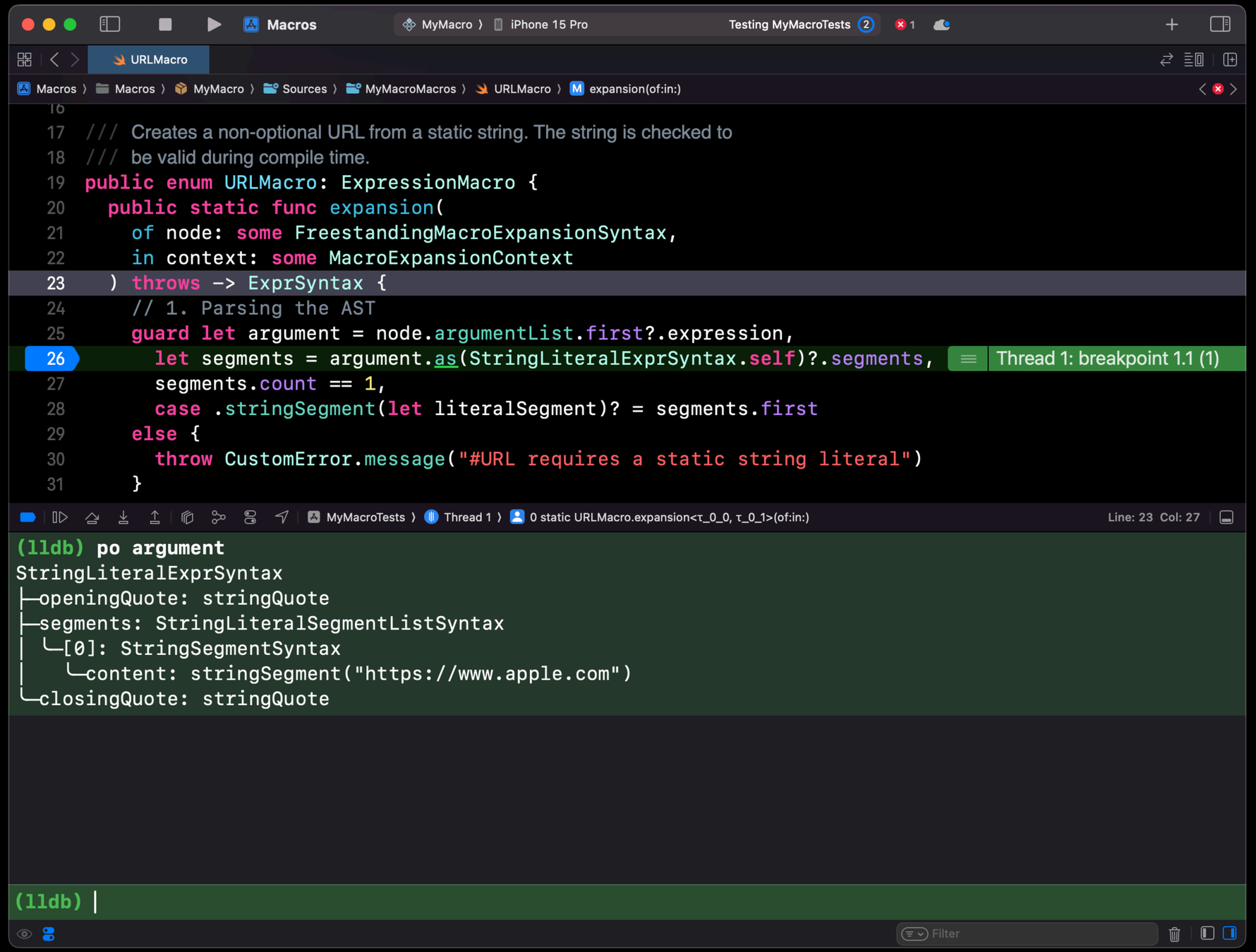
Macros
MyMacro 〉 iPhone 15 Pro
Testing MyMacroTests
URLMacro
Macros 〉 Macros 〉 MyMacro 〉 Sources 〉 MyMacroMacros 〉 URLMacro 〉 expansion(of:in:)
/// Creates a non-optional URL from a static string. The string is checked to
/// be valid during compile time.
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Thread 1: breakpoint 1.1 (1)
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case .stringSegment(let literalSegment)? = segments.first
else {
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}
MyMacroTests 〉 Thread 1 〉 0 static URLMacro.expansion<τ_0_0, τ_0_1>(of:in:)
Line: 23 Col: 27
(lldb) po argument
StringLiteralExprSyntax
├─openingQuote: stringQuote
├─segments: StringLiteralSegmentListSyntax
│ └─[0]: StringSegmentSyntax
│ └─content: stringSegment("https://www.apple.com")
└─closingQuote: stringQuote
(lldb)
Filter

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let goodUrl = #URL("https://www.apple.com")
URL(string: "https://www.apple.com")!                    #URL

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```

Malformed url: "https://www.ap ple.com"

#02 – @ReuseIdentifier

https://github.com/collisionspace/ReuseIdentifierMacro

```
@ReuseIdentifier
class CarouselCollectionViewCell {}

let reuseID = CarouselCollectionViewCell.reuseIdentifier
```

```swift
@ReuseIdentifier
class CarouselCollectionViewCell {}
    static var reuseIdentifier: String {
        "CarouselCollectionViewCell"
    }

let reuseID = CarouselCollectionViewCell.reuseIdentifier
```

```
/// A macro that produces a reuseIdentifier that's usually required
/// for UICollectionViewCells and UITableViewCells
@attached(member, names: named(reuseIdentifier))
public macro ReuseIdentifier() = #externalMacro(
    module: "ReuseIdentifierMacros",
    type: “ReuseIdentifierMacro"
)
```

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)
```

```swift
public struct ReuseIdentifierMacro: MemberMacro {
    public static func expansion(
        of node: AttributeSyntax,
        providingMembersOf declaration: some DeclGroupSyntax,
        in context: some MacroExpansionContext
    ) throws -> [SwiftSyntax.DeclSyntax] {
        guard let classDecl = declaration.as(ClassDeclSyntax.self) else {
            throw ReuseIdentifierError.onlyApplicableToClass
        }

        let reuseID = try VariableDeclSyntax("static var reuseIdentifier: String") {
            StringLiteralExprSyntax(content: classDecl.identifier.text)
        }

        return [
            DeclSyntax(reuseID)
        ]
    }
}
```

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        return [
            DeclSyntax(reuseID)
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    }
}
```

```swift
@ReuseIdentifier
class CarouselCollectionViewCell {}
    static var reuseIdentifier: String {
        "CarouselCollectionViewCell"
    }

let reuseID = CarouselCollectionViewCell.reuseIdentifier
```

#03 – @CaseDetection

https://github.com/apple/swift-syntax/tree/main/Examples/Sources/MacroExamples

```
enum Pet {
   case dog
   case cat(curious: Bool)

}

let pet: Pet = .cat(curious: true)

if case .cat = pet {
    print("Pet is cat")
}
```

```swift
@CaseDetection
enum Pet {
  case dog
  case cat(curious: Bool)

  var isDog: Bool {
    if case .dog = self {
      return true
    }

    return false
  }

  var isCat: Bool {
    if case .cat = self {
      return true
    }

    return false
  }
}
```

@CaseDetection

```
/// Add computed properties named `is<Case>` for each case
element in the enum.
@attached(member, names: arbitrary)
public macro CaseDetection() = #externalMacro(
    module: "MyMacroMacros",
    type: "CaseDetectionMacro"
)
```

```
/// Add computed properties named `is<Case>` for each case
element in the enum.
@attached(member, names: arbitrary)
public macro CaseDetection() = #externalMacro(
    module: "MyMacroMacros",
    type: "CaseDetectionMacro"
)
```

```swift
public enum CaseDetectionMacro: MemberMacro {
  public static func expansion(
    of node: AttributeSyntax,
    providingMembersOf declaration: some DeclGroupSyntax,
    in context: some MacroExpansionContext
  ) throws -> [DeclSyntax] {
    declaration.memberBlock.members
      .compactMap { $0.decl.as(EnumCaseDeclSyntax.self) }
      .map { $0.elements.first!.name }
      .map { ($0, $0.initialUppercased) }
      .map { original, uppercased in
        """
        var is\(raw: uppercased): Bool {
          if case .\(raw: original) = self {
            return true
          }

          return false
        }
        """
      }
  }
}
```

```swift
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    of node: AttributeSyntax,
    providingMembersOf declaration: some DeclGroupSyntax,
    in context: some MacroExpansionContext
  ) throws -> [DeclSyntax] {
    declaration.memberBlock.members
      .compactMap { $0.decl.as(EnumCaseDeclSyntax.self) }
      .map { $0.elements.first!.name }
      .map { ($0, $0.initialUppercased) }
      .map { original, uppercased in
        """
        var is\(raw: uppercased): Bool {
          if case .\(raw: original) = self {
```

```
        .map { $0.elements.first!.name }
        .map { ($0, $0.initialUppercased) }
        .map { original, uppercased in
          """
          var is\(raw: uppercased): Bool {
            if case .\(raw: original) = self {
              return true
            }

            return false
          }
          """
        }
    }
}
```

```
        .map { $0.elements.first!.name }
        .map { ($0, $0.initialUppercased) }
        .map { original, uppercased in
          """
          var is\(raw: uppercased): Bool {
            if case .\(raw: original) = self {
              return true
            }

            return false
          }
          """
        }
    }
}
```

```swift
@CaseDetection
enum Pet {
  case dog
  case cat(curious: Bool)

  var isDog: Bool {
    if case .dog = self {
      return true
    }

    return false
  }

  var isCat: Bool {
    if case .cat = self {
      return true
    }

    return false
  }
}
```

@CaseDetection

#04 – @EnvironmentValue & @EnvironmentStorage

https://github.com/Wouter01/SwiftUI-Macros/

```swift
import SwiftUI

struct SecondaryFontEnvironmentKey: EnvironmentKey {
    static var defaultValue: Font?
}

extension EnvironmentValues {
    var secondaryFont: Font? {
        get {
            self [SecondaryFontEnvironmentKey.self]
        }
        set {
            self [SecondaryFontEnvironmentKey.self] = newValue
        }
    }
}
```

```swift
import SwiftUI

@EnvironmentStorage
extension EnvironmentValues {
    var secondaryFont: Font?
}
```

```
26
27 @EnvironmentStorage
28 extension EnvironmentValues {
       @EnvironmentValue                    @EnvironmentStorage
29     var secondaryFont: Font?
30 }
31
```

```
@EnvironmentStorage
extension EnvironmentValues {
    @EnvironmentValue                                   @EnvironmentStorage
    var secondaryFont: Font?
        internal struct EnvironmentKey_secondaryFont: EnvironmentKey {
            static var defaultValue: Font?
        }
    {                                                   @EnvironmentValue
        get {
            self [EnvironmentKey_secondaryFont.self]
        }
        set {
            self [EnvironmentKey_secondaryFont.self] = newValue
        }
    }
}
```

```
/// Applies the @EnvironmentValue macro to each child in the scope.
/// This should only be applied on an EnvironmentValues extension.
@attached(memberAttribute)
public macro EnvironmentStorage() = #externalMacro(
    module: "SwiftUIMacrosImpl",
    type: “EnvironmentStorage"
)
```

```
/// Applies the @EnvironmentValue macro to each child in the scope.
/// This should only be applied on an EnvironmentValues extension.
@attached(memberAttribute)
public macro EnvironmentStorage() = #externalMacro(
    module: "SwiftUIMacrosImpl",
    type: “EnvironmentStorage"
)
```

```swift
public struct EnvironmentStorage: MemberAttributeMacro {
    public static func expansion(
        of node: AttributeSyntax,
        attachedTo declaration: some DeclGroupSyntax,
        providingAttributesFor member: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [AttributeSyntax] {

        // Only attach macro if member is a variable.
        // Otherwise, it will also get attached to the structs generated by @EnvironmentValue
        guard member.is(VariableDeclSyntax.self) else {
            return []
        }

        return [
            AttributeSyntax(
                atSignToken: .atSignToken(),
                attributeName: SimpleTypeIdentifierSyntax(name: .identifier("EnvironmentValue"))
            )
        ]
    }
}
```

```swift
public struct EnvironmentStorage: MemberAttributeMacro {
    public static func expansion(
        of node: AttributeSyntax,
        attachedTo declaration: some DeclGroupSyntax,
        providingAttributesFor member: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [AttributeSyntax] {

        // Only attach macro if member is a variable.
        // Otherwise, it will also get attached to the structs generated by @EnvironmentValue
        guard member.is(VariableDeclSyntax.self) else {
            return []
        }

        return [
            AttributeSyntax(
                atSignToken: .atSignToken(),
                attributeName: SimpleTypeIdentifierSyntax(name: .identifier("EnvironmentValue"))
            )
        ]
    }
}
```

```swift
public struct EnvironmentStorage: MemberAttributeMacro {
    public static func expansion(
        of node: AttributeSyntax,
        attachedTo declaration: some DeclGroupSyntax,
        providingAttributesFor member: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [AttributeSyntax] {

        // Only attach macro if member is a variable.
        // Otherwise, it will also get attached to the structs generated by @EnvironmentValue
        guard member.is(VariableDeclSyntax.self) else {
            return []
        }

        return [
            AttributeSyntax(
                atSignToken: .atSignToken(),
                attributeName: SimpleTypeIdentifierSyntax(name: .identifier("EnvironmentValue"))
            )
        ]
    }
}
```

```swift
public struct EnvironmentStorage: MemberAttributeMacro {
    public static func expansion(
        of node: AttributeSyntax,
        attachedTo declaration: some DeclGroupSyntax,
        providingAttributesFor member: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [AttributeSyntax] {

        // Only attach macro if member is a variable.
        // Otherwise, it will also get attached to the structs generated by @EnvironmentValue
        guard member.is(VariableDeclSyntax.self) else {
            return []
        }

        return [
            AttributeSyntax(
                atSignToken: .atSignToken(),
                attributeName: SimpleTypeIdentifierSyntax(name: .identifier("EnvironmentValue"))
            )
        ]
    }
}
```

```swift
public struct EnvironmentStorage: MemberAttributeMacro {
    public static func expansion(
        of node: AttributeSyntax,
        attachedTo declaration: some DeclGroupSyntax,
        providingAttributesFor member: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [AttributeSyntax] {

        // Only attach macro if member is a variable.
        // Otherwise, it will also get attached to the structs generated by @EnvironmentValue
        guard member.is(VariableDeclSyntax.self) else {
            return []
        }

        return [
            AttributeSyntax(
                atSignToken: .atSignToken(),
                attributeName: SimpleTypeIdentifierSyntax(name: .identifier("EnvironmentValue"))
            )
        ]
    }
}
```

```
26
27 @EnvironmentStorage
28 extension EnvironmentValues {
       @EnvironmentValue                    @EnvironmentStorage
29     var secondaryFont: Font?
30 }
31
```

```
/// Creates an unique EnvironmentKey for the variable and adds getters and setters.
/// The initial value of the variable becomes the default value of the EnvironmentKey.
@attached(peer, names: prefixed(EnvironmentKey_))
@attached(accessor, names: named(get), named(set))
public macro EnvironmentValue() = #externalMacro(
    module: "SwiftUIMacrosImpl",
    type: “AttachedMacroEnvironmentKey"
)
```

```
/// Creates an unique EnvironmentKey for the variable and adds getters and setters.
/// The initial value of the variable becomes the default value of the EnvironmentKey.
@attached(peer, names: prefixed(EnvironmentKey_))
@attached(accessor, names: named(get), named(set))
public macro EnvironmentValue() = #externalMacro(
    module: "SwiftUIMacrosImpl",
    type: “AttachedMacroEnvironmentKey"
)
```

```
/// Creates an unique EnvironmentKey for the variable and adds getters and setters.
/// The initial value of the variable becomes the default value of the EnvironmentKey.
@attached(peer, names: prefixed(EnvironmentKey_))
@attached(accessor, names: named(get), named(set))
public macro EnvironmentValue() = #externalMacro(
    module: "SwiftUIMacrosImpl",
    type: “AttachedMacroEnvironmentKey"
)
```

```swift
public struct AttachedMacroEnvironmentKey: PeerMacro {
    public static func expansion(
        of node: AttributeSyntax,
        providingPeersOf declaration: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [DeclSyntax] {

        // Skip declarations other than variables
        guard let varDecl = declaration.as(VariableDeclSyntax.self) else {
            return []
        }

        guard var binding = varDecl.bindings.first?.as(PatternBindingSyntax.self)else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.missingAnnotation))
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        binding.pattern = PatternSyntax(IdentifierPatternSyntax(identifier: .identifier("defaultValue")))

        let isOptionalType = binding.typeAnnotation?.type.is(OptionalTypeSyntax.self) ?? false
        let hasDefaultValue = binding.initializer != nil

        guard isOptionalType || hasDefaultValue else {
```

```swift
public struct AttachedMacroEnvironmentKey: PeerMacro {
    public static func expansion(
        of node: AttributeSyntax,
        providingPeersOf declaration: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [DeclSyntax] {

        // Skip declarations other than variables
        guard let varDecl = declaration.as(VariableDeclSyntax.self) else {
            return []
        }

        guard var binding = varDecl.bindings.first?.as(PatternBindingSyntax.self)else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.missingAnnotation))
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        binding.pattern = PatternSyntax(IdentifierPatternSyntax(identifier: .identifier("defaultValue")))

        let isOptionalType = binding.typeAnnotation?.type.is(OptionalTypeSyntax.self) ?? false
        let hasDefaultValue = binding.initializer != nil

        guard isOptionalType || hasDefaultValue else {
```

```swift
public struct AttachedMacroEnvironmentKey: PeerMacro {
    public static func expansion(
        of node: AttributeSyntax,
        providingPeersOf declaration: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [DeclSyntax] {

        // Skip declarations other than variables
        guard let varDecl = declaration.as(VariableDeclSyntax.self) else {
            return []
        }

        guard var binding = varDecl.bindings.first?.as(PatternBindingSyntax.self)else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.missingAnnotation))
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        binding.pattern = PatternSyntax(IdentifierPatternSyntax(identifier: .identifier("defaultValue")))

        let isOptionalType = binding.typeAnnotation?.type.is(OptionalTypeSyntax.self) ?? false
        let hasDefaultValue = binding.initializer != nil

        guard isOptionalType || hasDefaultValue else {
```

```swift
public struct AttachedMacroEnvironmentKey: PeerMacro {
    public static func expansion(
        of node: AttributeSyntax,
        providingPeersOf declaration: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [DeclSyntax] {

        // Skip declarations other than variables
        guard let varDecl = declaration.as(VariableDeclSyntax.self) else {
            return []
        }

        guard var binding = varDecl.bindings.first?.as(PatternBindingSyntax.self)else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.missingAnnotation))
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        binding.pattern = PatternSyntax(IdentifierPatternSyntax(identifier: .identifier("defaultValue")))

        let isOptionalType = binding.typeAnnotation?.type.is(OptionalTypeSyntax.self) ?? false
        let hasDefaultValue = binding.initializer != nil

        guard isOptionalType || hasDefaultValue else {
```

```swift
public struct AttachedMacroEnvironmentKey: PeerMacro {
    public static func expansion(
        of node: AttributeSyntax,
        providingPeersOf declaration: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [DeclSyntax] {

        // Skip declarations other than variables
        guard let varDecl = declaration.as(VariableDeclSyntax.self) else {
            return []
        }

        guard var binding = varDecl.bindings.first?.as(PatternBindingSyntax.self)else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.missingAnnotation))
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
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        }

        binding.pattern = PatternSyntax(IdentifierPatternSyntax(identifier: .identifier("defaultValue")))

        let isOptionalType = binding.typeAnnotation?.type.is(OptionalTypeSyntax.self) ?? false
        let hasDefaultValue = binding.initializer != nil

        guard isOptionalType || hasDefaultValue else {
```

```
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.missingAnnotation))
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        binding.pattern = PatternSyntax(IdentifierPatternSyntax(identifier: .identifier("defaultValue")))

        let isOptionalType = binding.typeAnnotation?.type.is(OptionalTypeSyntax.self) ?? false
        let hasDefaultValue = binding.initializer != nil

        guard isOptionalType || hasDefaultValue else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.noDefaultArgument))
            return []
        }

        return [
            """
            internal struct EnvironmentKey_\(raw: identifier): EnvironmentKey {
                static var \(binding)
            }
            """
        ]
    }
}
```

```
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        binding.pattern = PatternSyntax(IdentifierPatternSyntax(identifier: .identifier("defaultValue")))

        let isOptionalType = binding.typeAnnotation?.type.is(OptionalTypeSyntax.self) ?? false
        let hasDefaultValue = binding.initializer != nil

        guard isOptionalType || hasDefaultValue else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.noDefaultArgument))
            return []
        }

        return [
            """
            internal struct EnvironmentKey_\(raw: identifier): EnvironmentKey {
                static var \(binding)
            }
            """
        ]
    }
}
```

```
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.missingAnnotation))
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        binding.pattern = PatternSyntax(IdentifierPatternSyntax(identifier: .identifier("defaultValue")))

        let isOptionalType = binding.typeAnnotation?.type.is(OptionalTypeSyntax.self) ?? false
        let hasDefaultValue = binding.initializer != nil

        guard isOptionalType || hasDefaultValue else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.noDefaultArgument))
            return []
        }

        return [
            """
            internal struct EnvironmentKey_\(raw: identifier): EnvironmentKey {
                static var \(binding)
            }
            """
        ]
    }
}
```

```
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        binding.pattern = PatternSyntax(IdentifierPatternSyntax(identifier: .identifier("defaultValue")))

        let isOptionalType = binding.typeAnnotation?.type.is(OptionalTypeSyntax.self) ?? false
        let hasDefaultValue = binding.initializer != nil

        guard isOptionalType || hasDefaultValue else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.noDefaultArgument))
            return []
        }

        return [
            """
            internal struct EnvironmentKey_\(raw: identifier): EnvironmentKey {
                static var \(binding)
            }
            """
        ]
    }
}
```

```
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.missingAnnotation))
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        binding.pattern = PatternSyntax(IdentifierPatternSyntax(identifier: .identifier("defaultValue")))

        let isOptionalType = binding.typeAnnotation?.type.is(OptionalTypeSyntax.self) ?? false
        let hasDefaultValue = binding.initializer != nil

        guard isOptionalType || hasDefaultValue else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.noDefaultArgument))
            return []
        }

        return [
            """
            internal struct EnvironmentKey_\(raw: identifier): EnvironmentKey {
                static var \(binding)
            }
            """
        ]
    }
}
```

```
@EnvironmentStorage
extension EnvironmentValues {
    @EnvironmentValue                                   @EnvironmentStorage
    var secondaryFont: Font?
        internal struct EnvironmentKey_secondaryFont: EnvironmentKey {
            static var defaultValue: Font?
        }
    {                                                   @EnvironmentValue
        get {
            self [EnvironmentKey_secondaryFont.self]
        }
        set {
            self [EnvironmentKey_secondaryFont.self] = newValue
        }
    }
}
```

```
@EnvironmentStorage
extension EnvironmentValues {
    @EnvironmentValue                                    @EnvironmentStorage
    var secondaryFont: Font?
        internal struct EnvironmentKey_secondaryFont: EnvironmentKey {
            static var defaultValue: Font?
        }
    {                                                    @EnvironmentValue
        get {
            self [EnvironmentKey_secondaryFont.self]
        }
        set {
            self [EnvironmentKey_secondaryFont.self] = newValue
        }
    }
}
```

```swift
extension AttachedMacroEnvironmentKey: AccessorMacro {
    public static func expansion(
        of node: AttributeSyntax,
        providingAccessorsOf declaration: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [AccessorDeclSyntax] {

        // Skip declarations other than variables
        guard let varDecl = declaration.as(VariableDeclSyntax.self) else {
            return []
        }

        guard let binding = varDecl.bindings.first?.as(PatternBindingSyntax.self)else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.missingAnnotation))
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        return [
            """
            get {
                self[EnvironmentKey_\(raw: identifier).self]
            }
            """
```

```
extension AttachedMacroEnvironmentKey: AccessorMacro {
    public static func expansion(
        of node: AttributeSyntax,
        providingAccessorsOf declaration: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [AccessorDeclSyntax] {

        // Skip declarations other than variables
        guard let varDecl = declaration.as(VariableDeclSyntax.self) else {
            return []
        }

        guard let binding = varDecl.bindings.first?.as(PatternBindingSyntax.self)else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.missingAnnotation))
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        return [
            """
            get {
                self[EnvironmentKey_\(raw: identifier).self]
            }
            """
```

```swift
extension AttachedMacroEnvironmentKey: AccessorMacro {
    public static func expansion(
        of node: AttributeSyntax,
        providingAccessorsOf declaration: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [AccessorDeclSyntax] {

        // Skip declarations other than variables
        guard let varDecl = declaration.as(VariableDeclSyntax.self) else {
            return []
        }

        guard let binding = varDecl.bindings.first?.as(PatternBindingSyntax.self)else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.missingAnnotation))
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        return [
            """
            get {
                self[EnvironmentKey_\(raw: identifier).self]
            }
            """
```

```swift
extension AttachedMacroEnvironmentKey: AccessorMacro {
    public static func expansion(
        of node: AttributeSyntax,
        providingAccessorsOf declaration: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [AccessorDeclSyntax] {

        // Skip declarations other than variables
        guard let varDecl = declaration.as(VariableDeclSyntax.self) else {
            return []
        }

        guard let binding = varDecl.bindings.first?.as(PatternBindingSyntax.self)else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.missingAnnotation))
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        return [
            """
            get {
                self[EnvironmentKey_\(raw: identifier).self]
            }
            """
```

```swift
extension AttachedMacroEnvironmentKey: AccessorMacro {
    public static func expansion(
        of node: AttributeSyntax,
        providingAccessorsOf declaration: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [AccessorDeclSyntax] {

        // Skip declarations other than variables
        guard let varDecl = declaration.as(VariableDeclSyntax.self) else {
            return []
        }

        guard let binding = varDecl.bindings.first?.as(PatternBindingSyntax.self)else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.missingAnnotation))
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        return [
            """
            get {
                self[EnvironmentKey_\(raw: identifier).self]
            }
            """
```

```
        guard let varDecl = declaration.as(VariableDeclSyntax.self) else {
            return []
        }

        guard let binding = varDecl.bindings.first?.as(PatternBindingSyntax.self)else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.missingAnnotation))
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        return [
            """
            get {
                self[EnvironmentKey_\(raw: identifier).self]
            }
            """,
            """
            set {
                self[EnvironmentKey_\(raw: identifier).self] = newValue
            }
            """
        ]
    }
}
```

```
        guard let varDecl = declaration.as(VariableDeclSyntax.self) else {
            return []
        }

        guard let binding = varDecl.bindings.first?.as(PatternBindingSyntax.self)else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.missingAnnotation))
            return []
        }

        guard let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier.text else {
            context.diagnose(Diagnostic(node: Syntax(node), message: Feedback.notAnIdentifier))
            return []
        }

        return [
            """
            get {
                self[EnvironmentKey_\(raw: identifier).self]
            }
            """,
            """
            set {
                self[EnvironmentKey_\(raw: identifier).self] = newValue
            }
            """
        ]
    }
}
```

```
@EnvironmentStorage
extension EnvironmentValues {
    @EnvironmentValue                                   @EnvironmentStorage
    var secondaryFont: Font?
        internal struct EnvironmentKey_secondaryFont: EnvironmentKey {
            static var defaultValue: Font?
        }
    {                                                   @EnvironmentValue
        get {
            self [EnvironmentKey_secondaryFont.self]
        }
        set {
            self [EnvironmentKey_secondaryFont.self] = newValue
        }
    }
}
```

```
@EnvironmentStorage
extension EnvironmentValues {
    @EnvironmentValue                                   @EnvironmentStorage
    var secondaryFont: Font?
        internal struct EnvironmentKey_secondaryFont: EnvironmentKey {
            static var defaultValue: Font?
        }
    {                                                   @EnvironmentValue
        get {
            self [EnvironmentKey_secondaryFont.self]
        }
        set {
            self [EnvironmentKey_secondaryFont.self] = newValue
        }
    }
}
```

#05 – @AddPublisher

https://github.com/ShenghaiWang/SwiftMacros

```
struct MyType {
    @AddPublisher
    private let mySubject = PassthroughSubject<Void, Never>()
}
```

```
struct MyType {
    @AddPublisher
    private let mySubject = PassthroughSubject<Void, Never>()
        var mySubjectPublisher: AnyPublisher<Void, Never> {
            mySubject.eraseToAnyPublisher()
        }
}
```

```
/// Generate a Combine publisher to a Combine subject in order to
avoid overexposing subject variable
@attached(peer, names: suffixed(Publisher))
public macro AddPublisher() = #externalMacro(
    module: "Macros",
    type: “AddPublisher"
)
```

```
/// Generate a Combine publisher to a Combine subject in order to
avoid overexposing subject variable
@attached(peer, names: suffixed(Publisher))
public macro AddPublisher() = #externalMacro(
    module: "Macros",
    type: “AddPublisher"
)
```

```swift
public struct AddPublisher: PeerMacro {
    public static func expansion(
        of node: AttributeSyntax,
        providingPeersOf declaration: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [DeclSyntax] {
        guard let variableDecl = declaration.as(VariableDeclSyntax.self),
              variableDecl.modifiers.map({ $0.name.text }).contains("private") else {
            throw MacroDiagnostics.errorMacroUsage(
                message: "Please make the subject private and use the automated generated publisher variable outside of this type"
            )
        }

        guard let binding = variableDecl.bindings.first,
              let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier,
              let genericArgumentClause = binding.genericArgumentClause,
              ["PassthroughSubject", "CurrentValueSubject"].contains(binding.typeName) else {
            throw MacroDiagnostics.errorMacroUsage(
                message: "Can only be applied to a subject(PassthroughSubject/CurrentValueSubject) variable declaration"
            )
        }

        let publisher: DeclSyntax =
        """
        var \(raw: identifier.text)Publisher: AnyPublisher<\(genericArgumentClause.arguments)> {
            \(raw: identifier.text).eraseToAnyPublisher()
        }
        """
        return [publisher]
    }
}
```

```swift
public struct AddPublisher: PeerMacro {
    public static func expansion(
        of node: AttributeSyntax,
        providingPeersOf declaration: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
    ) throws -> [DeclSyntax] {
        guard let variableDecl = declaration.as(VariableDeclSyntax.self),
              variableDecl.modifiers.map({ $0.name.text }).contains("private") else {
            throw MacroDiagnostics.errorMacroUsage(
                message: "Please make the subject private and use the automated generated publisher variable outside of this type"
            )
        }

        guard let binding = variableDecl.bindings.first,
              let identifier = binding.pattern.as(IdentifierPatternSyntax.self)?.identifier,
              let genericArgumentClause = binding.genericArgumentClause,
              ["PassthroughSubject", "CurrentValueSubject"].contains(binding.typeName) else {
            throw MacroDiagnostics.errorMacroUsage(
                message: "Can only be applied to a subject(PassthroughSubject/CurrentValueSubject) variable declaration"
            )
        }
```

```swift
public struct AddPublisher: PeerMacro {
    public static func expansion(
        of node: AttributeSyntax,
        providingPeersOf declaration: some DeclSyntaxProtocol,
        in context: some MacroExpansionContext
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```
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            \(raw: identifier.text).eraseToAnyPublisher()
        }
        """
        return [publisher]
    }
}
```

```
struct MyType {
    @AddPublisher
    private let mySubject = PassthroughSubject<Void, Never>()
        var mySubjectPublisher: AnyPublisher<Void, Never> {
            mySubject.eraseToAnyPublisher()
        }
}
```

So do you still want to implement your own macros?

Here are a few pitfalls you really want to watch out for!

#01 – Macros operate on a portion of your code

```
struct Person {
    let firstName: String
    let lastName: String
}
```

```
struct Person {
    let firstName: String
    let lastName: String
}

extension Person {
    var fullName: String {
        "\(firstName) \(lastName)"
    }
}
```

```
@KeyPathIterable
struct Person {
    let firstName: String
    let lastName: String
}

extension Person {
    var fullName: String {
        "\(firstName) \(lastName)"
    }
}
```

```swift
@KeyPathIterable
struct Person {
    let firstName: String
    let lastName: String
}

extension Person {
    var fullName: String {
        "\(firstName) \(lastName)"
    }
}
```

```swift
@KeyPathIterable
struct Person {
    let firstName: String
    let lastName: String
}

extension Person {
    var fullName: String {
        "\(firstName) \(lastName)"
    }
}
```

⚠️ The macro `@KeyPathIterable` will NOT see the property `fullName`!

#02 – Macros operate on syntax, not semantics

```
protocol MyProtocol { }
```

```
protocol MyProtocol { }

extension Date: MyProtocol { }
```

```
protocol MyProtocol { }

extension Date: MyProtocol { }

struct User {
    let name: String
    let creationDate: Date
}
```

```swift
protocol MyProtocol { }

extension Date: MyProtocol { }

@MyMacro
struct User {
    let name: String
    let creationDate: Date
}
```

```swift
protocol MyProtocol { }

extension Date: MyProtocol { }

@MyMacro
struct User {
    let name: String
    let creationDate: Date
}
```

```swift
protocol MyProtocol { }

extension Date: MyProtocol { }

@MyMacro
struct User {
    let name: String
    let creationDate: Date
}
```

⚠️ It’s impossible for `@MyMacro` to know which properties conform to `MyProtocol`!

#03 – Macros operate on syntax, not semantics (again!)

```
String? /* means the same than */ Optional<String>
```

```
String? /* means the same than */ Optional<String>
[Int] /* means the same than */ Array<Int>
```

```
String? /* means the same than */ Optional<String>
[Int] /* means the same than */ Array<Int>
() -> Void /* means the same than */ () -> ()
```

String?

- TypeAnnotation
  - :
  - OptionalType
    - IdentifierType
      - **String**
    - **?**

Optional<String>

- TypeAnnotation
  - :
  - IdentifierType
    - **Optional**
    - GenericArgumentClause
      - **<**
      - GenericArgumentList
        - GenericArgument
          - IdentifierType
            - **String**
      - **>**

With Macro Toolkit

```
function.returnsVoid
```

Without Macro Toolkit

```
func returnsVoid(_ function: FunctionDeclSyntax) -> Bool {
    // Function can either have no return type annotation, `()`, `Void`, or a nested single
    // element tuple with a Void-like inner type (e.g. `((((((Void))))))` or `(((((Void)))))`)
    func isVoid(_ type: TypeSyntax) -> Bool {
        if type.description == "Void" || type.description == "()" {
            return true
        }

        guard let tuple = type.as(TupleTypeSyntax.self) else {
            return false
        }

        if let element = tuple.elements.first, tuple.elements.count == 1 {
            let isUnlabeled = element.name == nil && element.secondName == nil
            return isUnlabeled && isVoid(TypeSyntax(element.type))
        }
        return false
    }

    guard let returnType = function.output?.returnType else {
        return false
    }
    return isVoid(returnType)
}
```

https://github.com/stackotter/swift-macro-toolkit

Recap

Recap

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- Swift Macros are incredibly powerful…

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- Swift Macros are incredibly powerful…
- …but they are also incredibly complex!

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- Swift Macros are incredibly powerful…
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- Writing a macro is a different skill than writing app-level code

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- The community has implemented some great macros…

Recap

- Swift Macros are incredibly powerful…
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- Writing a macro is a different skill than writing app-level code
- The community has implemented some great macros…
- …but understanding how they work is really important!

Recap

- Swift Macros are incredibly powerful…
- …but they are also incredibly complex!
- Writing a macro is a different skill than writing app-level code
- The community has implemented some great macros…
- …but understanding how they work is really important!
- It’s totally possible to roll out your own macro…

Recap

- Swift Macros are incredibly powerful…
- …but they are also incredibly complex!
- Writing a macro is a different skill than writing app-level code
- The community has implemented some great macros…
- …but understanding how they work is really important!
- It’s totally possible to roll out your own macro…
- …but be (very) aware of what you’re getting yourself into!


That's all Folks!

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