SwiftUI Development

iOS 16 • Xcode 14

STUDENT GUIDE

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Classroom materials for a course that provides a rapid introduction to iOS development in SwiftUI. Includes coverage of the Combine framework.

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SwiftUI Development

STUDENT GUIDE

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Section 1: SwiftUI Basics

The SwiftUI Framework

- Integrates with UIKit, AppKit (macOS), and WatchKit.
- UIKit integration depends on UIKit components such as `UIView`, `UIViewController`.
    - Dependencies are largely hidden; however,
    - Your code may sometimes need to call directly into UIKit.
- Allows declarative specification of UI.
- Aims to reduce the amount of state maintained by UI objects.
- Makes extensive use of *property wrappers* to enable reactive behavior.

Developer Tools

- Xcode's SwiftUI Preview Pane
- iPhone, iPad, and Apple Watch Simulators
- SF Symbols
- Instruments

View Protocol

- Views are typically represented by Swift structs that conform to the `View` protocol.
- The `View` protocol defines a computed property named `body` that is accessed on state changes to render the view's content.

```
public protocol View {

    /// The type of view representing the body of this view.
    ///
    /// When you create a custom view, Swift infers this type from your
    /// implementation of the required `body` property.
    associatedtype Body : View

    /// The content and behavior of the view.
    @ViewBuilder var body: Self.Body { get }
}
```

Defining a View

- Define a struct that conforms to the `View` protocol.
- Implement the `body` computed property defined in the protocol.

```
import SwiftUI

struct MyView: View {

    var body: some View {
        Text("Hello, world!")
    }
}
```

ViewBuilders

- Note that in the `View` protocol, `body` is annotated with `@ViewBuilder`.
  - Leverages Swift's `@resultBuilder` feature.
  - Allows the trailing closure to define up to ten views.
  - Automatically nests views in a `TupleView` struct returned by the the body property's getter.

```
import SwiftUI

struct MyView: View {

    var body: some View {
        Text("One")
        Text("Two")
    }
}
```

@resultBuilder

- Streamlines code defining nested data structures — useful for implementing DSLs.
- Provides a number of `buildBlock()` result building methods.
- For example, you could define a custom StringBuilder:

```
@resultBuilder struct StringBuilder {
    static func buildBlock(_ components: String...) -> String {
        components.joined(separator: "")
    }
}
```

- You could then use `@StringBuilder` to annotate a closure passed to a struct's initializer, as follows:

```
struct StringGroup {
    var text: String
    init(@StringBuilder builder: () -> String) {
        text = builder()
    }
}
```

- `@StringBuilder` could then be used to annotate properties:

```
@StringBuilder var message: String {
    "Hello"
    " "
    "World"
    "!"
}
// The following would print "Hello World!"
print(message)
```

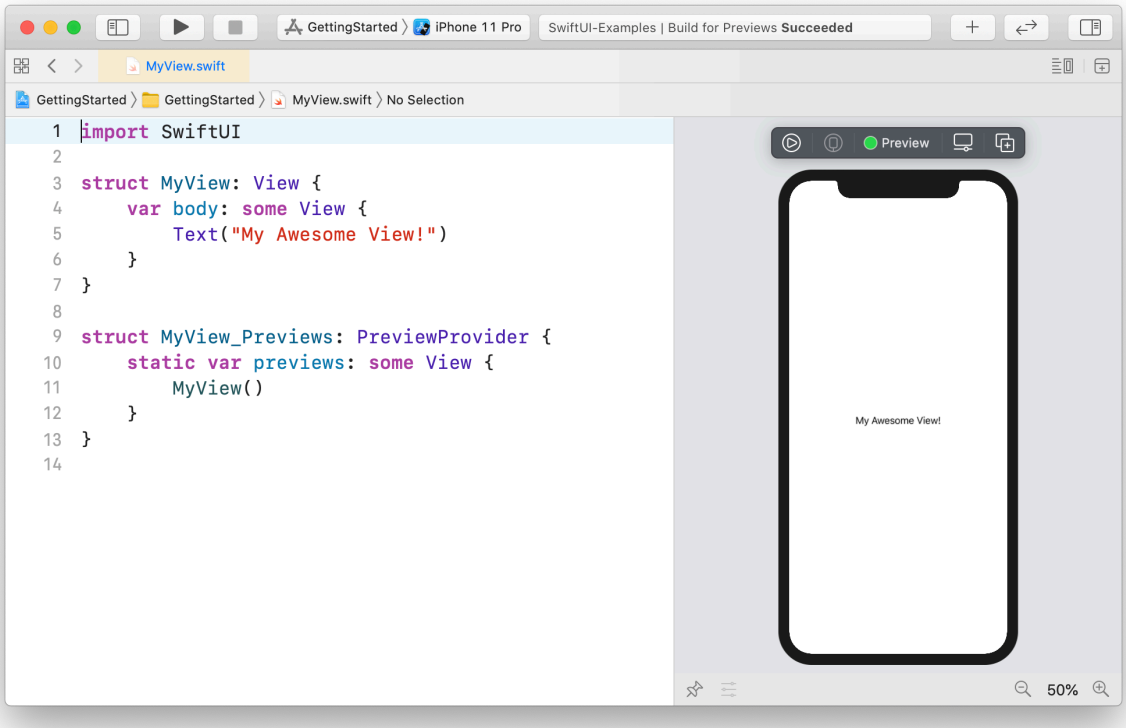
Xcode Previews

Define a struct that conforms to the `PreviewProvider` protocol to implement a live preview in Xcode.

```
struct MyView_Previews: PreviewProvider {
    static var previews: some View {
        MyView()
    }
}
```

Xcode automatically executes a Simulator instance and presents it in a canvas view on the right.

The canvas view can be toggled on and off via **Cmd-Option-Return**.



Images and Symbols

- `Image` is a struct that defines a View wrapper for image data.
- You can initialize by providing the name of an image in one of your app's asset catalogs.

```
Image(name: "Foo")
```

- SFSymbols — vector art provided and maintained by Apple's design team.
- Use the SFSymbols app to browse the collection.
- Use the `systemName` parameter to specify an SFSymbol:

```
Image(systemName: "sunrise.fill")
```

Container Views

- An important layout mechanism is provided by *layout container* views such as `HStack`, `VStack`, and `ZStack`.
- Layout containers initiate a simple sequence of steps:
    1. Container views offer a size to each of their children.
    2. Child views then determine how much of the offered size they want to use.
    3. The container views then position their children.
- Note that there are two other types of container views: *collection containers*, and *presentation containers* that we'll cover later.

Modifiers

- Use modifiers to configure a view's appearance and behavior.
- Modifiers are methods that return the current view wrapped in a view that provides some additional feature(s).
- For example, the code below applies a `foregroundColor(_:)` modifier to a `Text` view:

```
Text("Hello World!")
    .foregroundColor(.green)
```

- Modifiers can be chained:

```
Text("Hello World!")
    .foregroundColor(.green)
    .padding()
    .border(.purple)
```

View-Specific Modifiers

- View types can provide their own custom modifiers.
- For example, `fontWeight(_:)` is declared in `Text`. Trying to apply it to something that is not an instance of Text is a compile error.

```
Text("Hello World!")
    .foregroundColor(.green)
    .padding()
    .border(.purple)
    .fontWeight(.heavy) // Compile error.
```

To fix the above error, change the order of the modifiers:

```
Text("Hello World!")
    .foregroundColor(.green)
    .fontWeight(.heavy)
    // .fontWeight(_:) works here because .foregroundColor(_:)
    // returns Text, whereas the next modifier, .padding(),
    // returns View.
    .padding()
    .border(.purple)
```

Managing Layout

Views for Managing Layout

- Stack views:
  - `HStack, VStack, ZStack`
  - `LazyHStack, LazyVStack`
- Grid views: `LazyHGrid` and `LazyVGrid`
- Lists: `List` and `ForEach` (note that `ForEach` defers layout to its container view.)
- `Group` views and `Spacer` views
- Navigation views and sheets

Modifiers for Managing Layout

- `padding`
- `frame`
- `layoutPriority`
- `overlay and background`

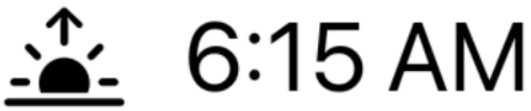
Stack Views

- Stacks offer space to their children in order, from the 'least flexible' child to the 'most flexible.'
- Examples of layout flexibility:
  - An `Image` calculates its size based on its content, and always prefers to be that size.
  - A `Text` also calculates its size from its content, but is a little more flexible than an `Image`.
  - A `RoundedRectangle` is even more flexible — it simply takes whatever size is offered.
- After calculating the sizes of its children, a stack sizes itself to fit.
- Use the `.layoutPriority(Double)` modifier to override the default order in which space is offered.
  - Default priority is `0`.

Horizontal Stacks

- To define a horizontal layout, you can nest subviews in an instance of `HStack`, initialized with a `ViewBuilder`.
- You can optionally define vertical alignment and/or spacing between nested elements as parameter values.
- Modifiers can be applied directly to a stack, as shown below.

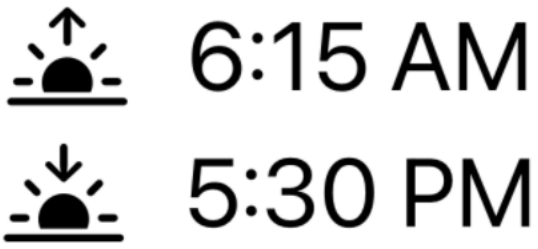
```
struct WeatherView: View {
    var body: some View {
        HStack(spacing: 18) {
            Image(systemName: "sunrise.fill")
            Text("6:15 AM")
        }
        .font(.system(size: 36))
    }
}
```



Vertical Stacks

- As with instances of `HStack`, a `VStack` can be initialized with a `ViewBuilder`, as well as spacing and horizontal alignment (both optional).

```
struct WeatherListView: View {
    var body: some View {
        VStack(spacing: 8) {
            HStack(spacing: 18) {
                Image(systemName: "sunrise.fill")
                Text("6:15 AM")
            }
            HStack(spacing: 18) {
                Image(systemName: "sunset.fill")
                Text("5:30 PM")
            }
        }
        .font(.system(size: 36))
    }
}
```



ZStacks

- Similar to the other stack types, you initialize a `ZStack` with a `ViewBuilder`, as well as an optional alignment parameter.
- You can specify alignment to any edge or corner, for example `.top`, or `.topLeading`.

```
ZStack {
    RoundedRectangle(cornerRadius: 15)
        .fill(.orange)
    RoundedRectangle(cornerRadius: 15)
        .fill(Color(white: 1, opacity: 0.9))
    RoundedRectangle(cornerRadius: 15)
        .stroke(.orange, lineWidth: 5)
    Image(systemName: "star.circle")
        .font(.system(size: 60, weight: .light))
        .foregroundColor(.indigo.opacity(0.5))
}
.frame(height: 80)
```

Custom Views

- To create a custom view type, define a struct that conforms to the `View` protocol.
- That requires your struct to implement the `body` property.

```
struct WeatherCell: View {
    let imageName: String
    let time: String

    var body: some View {
        HStack(spacing: 18) {
            Image(systemName: imageName)
            Text(time)
        }
    }
}
```

- Creating instances:

```
struct WeatherListView: View {
    var body: some View {
        VStack(spacing: 8) {
            WeatherCell(imageName: "sunrise.fill", time: "6:15 AM")
            WeatherCell(imageName: "sunset.fill", time: "5:30 PM")
        }
        .font(.system(size: 36))
    }
}
```

Shapes – 1

- Use shapes for simple design composition. (For more sophisticated custom drawing, use a `Canvas` view.)
- Use ShapeStyle objects to configure `fill` and `stroke` styles, for example using a `Material` or `Gradient` style.
- The example below strokes a `Circle` with an `AngularGradient`:

```
let gradient = AngularGradient(
    colors: [.red, .orange, .yellow, .green, .blue, .purple, .pink],
    center: .center
)

var body: some View {
    ZStack {
        Circle()
            .stroke(gradient, lineWidth: 20)
            .frame(width: 100, height: 100)
    }
}
```

Shapes – 2

- The following example adds a background material to a `Text` view and places it on top of the `Circle` from the previous example.

```
let gradient = AngularGradient(
    colors: [.red, .orange, .yellow, .green, .blue, .purple, .pink],
    center: .center
)

var body: some View {
    ZStack {
        Circle()
            .stroke(gradient, lineWidth: 20)
            .frame(width: 100, height: 100)
        Text("Hello World!")
            .font(.system(size: 24).bold())
            .frame(width: 140, height: 140)
            .background(.ultraThinMaterial)
    }
}
```

Conditional Views

- SwiftUI supports using `if…else` constructs and `switch` statements as a way to conditionally include views.

```
struct ConditionalView: View {
    @State var isSunny = false

    var body: some View {
        VStack {
            Spacer()
            if isSunny {
                Text("The weather is sunny.")
                    .padding()
                    .frame(width: 140, height: 140)
                    .border(.yellow, width: 6)
            } else {
                Image(systemName: "cloud.sun.rain.fill")
                    .font(.system(size: 60))
                    .padding(20)
                    .background(.gray)
            }
            Button(action: toggleWeather,
                   label: { Text("Toggle") })
            Spacer()
        }
        .symbolRenderingMode(.multicolor)
        .font(.system(size: 24))
    }

    func toggleWeather() {
        isSunny.toggle()
    }
}
```

GeometryReader

- `GeometryReader` is view that acts as a wrapper for views that need access to their size and position.
- You configure a geometry reader with a closure that takes a GeometryProxy as its only argument. The proxy is a wrapper for information about the container view's frame.

```
struct Geometry: View {
    var body: some View {
        HStack {
            GeometryReader { geometry in
                let width = geometry.size.width / 2
                let height = geometry.size.height / 2
                Color.blue
                    .frame(width: width, height: height)
                    .position(x: width, y: height)
            }
        }
        .frame(width: 180, height: 80, alignment: .center)
        .background(.yellow)
    }
}
```

Section 2: Property Wrappers

Property Wrappers – 1

Property wrappers make it convenient to observe (and react to) changes to properties in pre-defined ways.

For example, suppose you want certain properties to always contain capitalized strings.

You could add property observers on a case-by-case basis:

```
struct Person {
    var firstName: String {
        didSet { firstName = firstName.capitalized }
    }
    // Etc...
}
```

Property Wrappers – 2

However, that approach could lead to dual maintenance. Instead, you could define a wrapper struct to encapsulate the required behavior:

```
@propertyWrapper struct Capitalized {
    var wrappedValue: String {
        didSet { wrappedValue = wrappedValue.capitalized }
    }

    init(wrappedValue: String) {
        self.wrappedValue = wrappedValue.capitalized
    }
}
```

- `@propertyWrapper` streamlines definition of wrapper structs.
- Only requirement is a property named `wrappedValue`.
- Can optionally provide a computed property named `projectedValue`.
    - We'll see later how `projectedValue` gets used.

Property Wrappers – 3

You could then wrap individual properties by simply annotating them:

```
struct Person {
    @Capitalized var firstName: String
    @Capitalized var lastName: String
}



func testCapitalized() {
    var fred = Person(firstName: "fred", lastName: "smith")
    print("\(fred.firstName) \(fred.lastName)")
    // Prints "Fred Smith"
}
```

Property Wrappers – 4

Conceptually, a property wrapper is just a struct that contains a wrapped value.

```
// A wrapper struct that accesses its stored value via a computed
// property.
struct CapitalizedString {
    private var _wrappedValue: String

    var wrappedValue: String {
        get { _wrappedValue }
        set { _wrappedValue = newValue.capitalized }
    }

    init(wrappedValue: String) {
        self._wrappedValue = wrappedValue.capitalized
    }
}
```

However, this could be awkward to use without the `@propertyWrapper` feature:

```
struct Person {
    ...
    var middleName: CapitalizedString
}

func testCapitalized() {
    fred.middleName = CapitalizedString(wrappedValue: "xavier")
    print(fred.middleName.wrappedValue)
    // Prints "Xavier"
}
```

Section 3: Bindings and State

@State

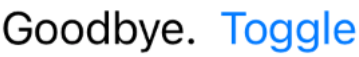
- `@State` is a property wrapper for a value that represents temporary view state.
- Underlying type is:

```
@frozen @propertyWrapper struct State<Value>
```

- `@State` causes the wrapped value to be copied to heap, and maintained there on your behalf. That allows a `View` to 'remember' the state it was in it (the `View`) is recreated.
- When the wrapped value changes, SwiftUI automatically calls `body` on any views that reference the property to get their updated content.
- The *projected value* of an `@State` property is of type `Binding<T>`.

@State Example

```
struct HelloView: View {
    @State private var isSayingHello = true

    var body: some View {
        HStack {
            Text(isSayingHello ? "Hello!" : "Goodbye.")
            Button(action: toggle,
                   label: { Text("Toggle") })
        }
    }

    func toggle() {
        isSayingHello.toggle()
    }
}
```

Before toggling:	**After toggling:**
	

@Binding

- `@Binding` is a property wrapper for a read-write value.
- Underlying type is:

```
@propertyWrapper struct Binding<Value>
```

- Use a `$` prefix to pass a binding (rather than its underlying value) as an argument.

```
struct ContentView: View {
    @State private var isVisible = false

    var body: some View {
        VStack {
            Toggle("Show Message", isOn: $isVisible)

            Text(isVisible ? "Hello, World!" : "")
        }
        .frame(width: 180)
    }
}
```

Animation

- SwiftUI can animate changes to any of the following:
  - The view hierarchy (a View being added or removed)
  - A subset of `ViewModifier` argument values
  - Shapes (e.g., Rectangle, Circle, Path, etc.)

Implicit Animations

- Define an implicit animation with the `.animation(_:, value:)` view modifier.

```
struct AnimateAllTheThings: View {
    @State var isRotating = false

    var body: some View {
        VStack {
            Spacer()
            Text("Hello, World!")
                .bold()
                .padding()
                .foregroundColor(.white)
            // Animatable modifiers
                .background(isRotating ? .pink : .purple)
                .opacity(isRotating ? 0.5 : 1.0)
            // Animatable geometry effects
                .transformEffect(CGAffineTransform(translationX: 0,
                                                   y: isRotating ? 100 : 0))
                .scaleEffect(isRotating ? CGSize(width: 1.5, height: 1.5)
                                        : CGSize(width: 1, height: 1))
                .rotationEffect(Angle(degrees: isRotating ? 400 : 0))
            // Implicit animation configuration
                .animation(.easeInOut(duration: 1), value: isRotating)
            Spacer()
            Button(action: rotate, label: { Text("Rotate") })
                .buttonStyle(.bordered)
            Spacer()
        }
    }

    private func rotate() {
        isRotating.toggle()
        DispatchQueue.main.asyncAfter(deadline: .now() + 1) {
            isRotating.toggle()
        }
    }
}
```

Explicit Animations

- Define an explicit animation as the body of a call to the `withAnimation()` function.

```
struct AnimatedCrossDisolve: View {
    @State private var isDefault = true

    var body: some View {
        ZStack {
            if (isDefault) {
                Circle()
                    .fill(Color.blue)
                    .frame(width: 100, height: 100)
            } else {
                Rectangle()
                    .fill(Color.green)
                    .frame(width: 100, height: 100)
            }
        }
        .onTapGesture { crossDissolve() }
    }

    func crossDissolve() {
        withAnimation(.easeInOut(duration: 1)) {
            isDefault.toggle()
        }
    }
}
```

Gestures – 1

- SwiftUI provides modifiers for configuring actions to be performed in response to gestures.
- Gesture modifiers provide three optional callbacks: `updating(_:body:)`, `onChanged(_:)`, and `onEnded(_:)`.
- For convenience, View provides an `onTapGesture(_:)` modifier.

```
struct TapGestureView: View {
    @State private var isAlternateColor = false

    var body: some View {
        Circle()
            .fill(isAlternateColor ? .green : .blue)
            .frame(width: 80, height: 80)
            .onTapGesture {
                isAlternateColor.toggle()
            }
    }
}
```

Gestures – 2

- For more complex gestures, use the general-purpose `gesture(_:)` modifier.

```
struct RotationGestureView: View {
    @State private var angle = Angle(degrees: 0)

    var rotationGesture: some Gesture {
        RotationGesture()
            .onChanged { angle = $0 }
    }

    var body: some View {
        Color.blue
            .frame(width: 160, height: 80)
            .rotationEffect(angle)
            .gesture(rotationGesture)
    }
}
```

@Published

- The `@Published` property wrapper publishes changes to its wrapped value.
- Under the hood the property wrapper publishes changes by calling `objectWillChange.send()` on `self` (the `ObservableObject` that contains it).
- SwiftUI views automatically update any time an `@Published` property they're bound to publishes a value change.
- Note that unlike `@State` (and `@StateObject`, `@Binding`, and `@ObservedObject`, for that matter), the *projected value* of `@Published` is a *publisher* (not a binding)!
- `@Published` properties are generally only used in view models. Note that they can't be used in structs — only in classes.

ObservableObject

- The `ObservableObject` protocol defines a single property, `objectWillChange` of type `ObjectWillChangePublisher`.
- The protocol conforms to `AnyObject`, so it can only be implemented by a class (i.e., it can't be implemented by a struct or enum).
- That means instances are *passed by reference*, unlike structs and enums, which are passed by value.
- An `ObservableObject` calls its `objectWillChange` publisher's `send()` method to broadcast pending value changes to any of its `@Published` properties.

@StateObject

- `@StateObject` is a property wrapper for an `ObservableObject`.
- Underlying type is:

```
@propertyWrapper struct StateObject<ObjectType> where ObjectType : ObservableObject
```

- SwiftUI creates a new instance of the `ObservableObject` once per instance of the `View` that declares the object.
- When published properties of the observable object change, SwiftUI automatically updates any parts of the view that depend on their values.
- The *projected value* of a `@StateObject` property is a binding to the properties of the wrapped value (which is typically a view model).

@Published Example – 1

@Published Property: ViewModel Implementation

```
struct Person {
    var name: String
    var age: Int
}

final class PersonViewModel: ObservableObject {
    @Published var person: Person?

    init() {
        loadPerson()
    }

    // Simulated fetch
    private func loadPerson() {
        person = Person(name: "Fred Smith", age: 30)
    }

    func change(name: String, age: Int) {
        person?.name = name
        person?.age = age
    }
}
```

@Published Example – 2

@Published Property: View References

```
let values:[(String, Int)] = [
    ("Rob Jones", 27), ("Jill Brown", 25), ("Jan Smith", 33),
    ("Joe James", 27), ("Pat Marks", 25), ("Will Trent", 33),
]

struct PersonView: View {
    @StateObject var viewModel = PersonViewModel()

    var body: some View {
        Form {
            HStack {
                Text("Name:")
                Text("\(viewModel.person?.name ?? "unknown")")
            }
            HStack {
                Text("Age:")
                Text("\(viewModel.person?.age ?? 0)")
            }
            HStack {
                Button(action: change, label: { Text("Change") })
            }
        }
    }

    func change() {
        let (name, age) = values[Int.random(in: 0..<values.count)]
        viewModel.change(name: name, age: age)
    }
}
```

@ObservedObject

- `@ObservedObject` is another property wrapper for an `ObservableObject`.
- Underlying type is:

```
@propertyWrapper struct ObservedObject<ObjectType> where ObjectType : ObservableObject
```

- An observed object is just a reference to an `ObservableObject` owned by another view, and passed in as an argument to an initializer.
- The *projected value* of an `@ObservedObject` property is a binding to the properties of the wrapped value (which is typically a view model).

@ObservedObject Example – 1

- We could take `PersonView` from the previous example and simply change the annotation on the `viewModel` property.

Original

```
struct PersonView: View {
    @StateObject var viewModel = PersonViewModel()
```

New

```
struct PersonView_1: View {
    @ObservedObject var viewModel: PersonViewModel
```

- Other views could then potentially share a reference to that same viewModel:

```
struct PersonView_2: View {
    @ObservedObject var viewModel: PersonViewModel

    var body: some View {
        VStack {
            HStack {
                Text("Name:")
                Text("\(viewModel.person?.name ?? "unknown")")
            }
            HStack {
                Text("Age:")
                Text("\(viewModel.person?.age ?? 0)")
            }
        }
    }
}
```

@ObservedObject Example – 2

- A parent view could then instantiate the view model as a `@StateObject` and pass it as parameter to both views:

```
struct ObservedObjectView: View {
    @StateObject private var personViewModel = PersonViewModel()

    var body: some View {
        TabView {
            PersonView_1(viewModel: personViewModel)
                .tabItem {
                    Image(systemName: "person")
                    Text("Person Form")
                }
            PersonView_2(viewModel: personViewModel)
                .tabItem {
                    Image(systemName: "person.2")
                    Text("Person Stack")
                }
        }
    }
}
```

@Environment

- Use the `@Environment` property wrapper to access values stored in the environment.
- It takes an initializer value of type `KeyPath` that conceptually names the environment value you're interested in.

```
@Environment(\.colorScheme) var colorScheme: ColorScheme
```

- System-provided values are defined in the `EnvironmentValues` struct.
- You can use the `environment(_:_:)` view modifier to set or override values, but in most cases, there are existing view modifiers for that purpose.

@Environment Example

```
struct EnvironmentContentView: View {
    // Reads the current color scheme inherited from
    // parent view
    @Environment(\.colorScheme) var colorScheme: ColorScheme

    var body: some View {
        VStack(spacing: 4) {
            Text("Hello, World!")
            Text("Have a Nice " +
                 (colorScheme == .dark ? "Night!" : "Day!"))
            Image(systemName: colorScheme == .dark
                  ? "moon.circle.fill"
                  : "sun.max.fill")
        }
        // Explicitly sets values in VStack's environment.
        // Note that there are existing modifiers for each of these.
        .environment(\.font, Font.system(size: 30))
        .environment(\.symbolRenderingMode, .multicolor)
    }
}


struct Environment_Previews: PreviewProvider {
    static var previews: some View {
        EnvironmentContentView()
        EnvironmentContentView()
        // Sets the color scheme in the environment
            .preferredColorScheme(.dark)
    }
}
```

@EnvironmentObject

- `@EnvironmentObject` is property wrapper for an `ObservableObject` passed in the environment.
- Underlying type is:

```
@propertyWrapper struct EnvironmentObject<ObjectType> where ObjectType :
ObservableObject
```

- You use an environment object as an alternative to an `@ObservedObject` when you want to share the reference more broadly, without having to explicitly pass it everywhere it may be needed.
- The *projected value* of an `@EnvironmentObject` property is a binding to the properties of the wrapped value (which is typically a view model).

@EnvironmentObject Example – 1

- We could again take `PersonView` from the previous example and simply change the annotation on the `viewModel` property.

Original

```
struct PersonView_1: View {
    @ObservedObject var viewModel = PersonViewModel()
```

New

```
struct PersonView_3: View {
    @EnvironmentObject var viewModel: PersonViewModel
```

- Other views could also inherit a reference to that view model.

```
struct PersonView_4: View {
    @EnvironmentObject var viewModel: PersonViewModel

    var body: some View {
        VStack {
            HStack {
                Text("Name:")
                Text("\(viewModel.person?.name ?? "unknown")")
            }
            HStack {
                Text("Age:")
                Text("\(viewModel.person?.age ?? 0)")
            }
        }
    }
}
```

@EnvironmentObject Example – 2

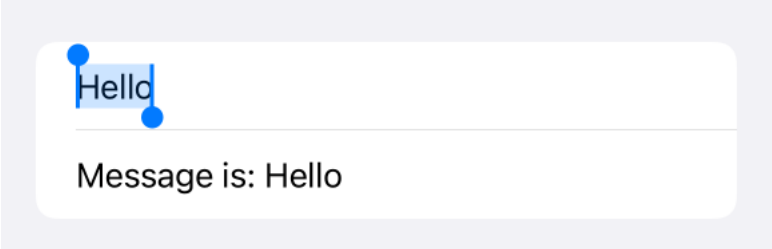
- A parent view could then instantiate the view model as a `@StateObject` and add it to the environment of a view by using the `environmentObject(:_)` view modifier:

```
struct EnvironmentObjectView: View {
    @StateObject private var personViewModel = PersonViewModel()

    var body: some View {
        TabView {
            PersonView_3()
                .tabItem {
                    Image(systemName: "person")
                    Text("Person Form")
                }
            PersonView_4()
                .tabItem {
                    Image(systemName: "person.2")
                    Text("Person Stack")
                }
        }
        .environmentObject(personViewModel)
    }
}
```

Editing Text – 1

- Use `TextField` to edit a single line of text, and `TextEditor` for multiline editing.
- You configure a text field with a placeholder string and a *binding* to the value to be edited.

```
struct TextFieldBasicsView: View {
    @State private var message = ""

    var body: some View {
        Form {
            TextField("Message", text: $message)
            Text("Message is: \(message)")
        }
    }
}
```



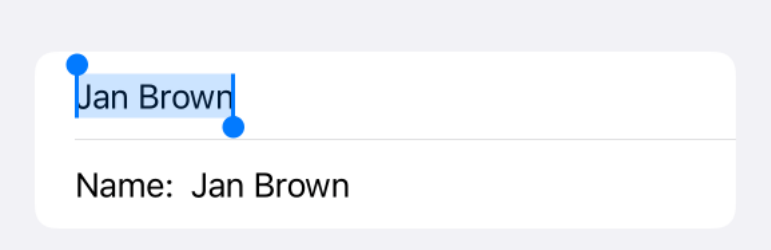
Editing Text – 2

- You can use an @Published property of your view model to track the text field's value, and update model values is it changes.

```
final class PersonViewModel_2: ObservableObject {
    @Published var person: Person?

    @Published var name: String = "" {
        didSet { person?.name = name }
    }
```

- Then configure the field with a binding to the published property.

```
struct EditablePersonView: View {
    @EnvironmentObject private var viewModel: PersonViewModel_2

    var body: some View {
        Form {
            TextField("Name", text: $viewModel.name)
            HStack {
                Text("Name:")
                Text("\(viewModel.person?.name ?? "unknown")")
            }
       }
    }
}
```

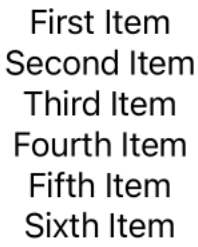


Section 4: Working with Collections

ForEach – 1

- Use `ForEach` to configure a list of repeating views based on a collection of data.
- If the elements of the collection don't conform to `Identifiable`, you need to provide an additional `id` parameter in the initializer.

```
struct Collections_1: View {
    let strings = ["First Item", "Second Item", "Third Item",
                   "Fourth Item", "Fifth Item", "Sixth Item"]

    var body: some View {
        VStack {
            ForEach(strings, id: \.self) { string in
                Text(string)
            }
        }
    }
}
```



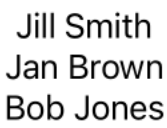
ForEach Example – 1

```
struct Collections_1: View {
    var body: some View {
        let colors: [Color] = [.red, .orange, .yellow, .green, .blue,
                               .indigo, .purple, .cyan, .teal, .brown]

        VStack {
            ForEach(colors, id: \.self) { color in
                ColorDescription(color: color)
            }
        }
    }
}

struct ColorDescription: View {
    let color: Color

    var body: some View {
        HStack {
            HStack {
                Text("\(color.description.capitalized)")
                    .font(.system(size: 26, weight: .light))
                Spacer()
            }
            .frame(width: 100)

            color
        }
        .padding()
    }
}
```

ForEach – 2

- Conformance with Identifiable simply requires a property name id whose values are guaranteed to be unique.

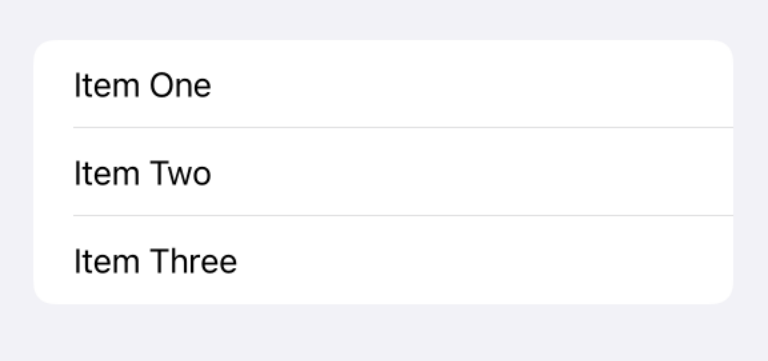
```
struct Contact: Identifiable {
    let id = UUID()
    var name: String
}

struct Collections_2: View {
    let contacts: [Contact] = [
        Contact(name: "Jill Smith"),
        Contact(name: "Jan Brown"),
        Contact(name: "Bob Jones"),
    ]

    var body: some View {
        VStack {
            ForEach(contacts) { contact in
                Text(contact.name)
            }
        }
    }
}
```



List Views – 1

- A List presents its content in tabular form in a scrollable area.
- It draws separators between elements by default.

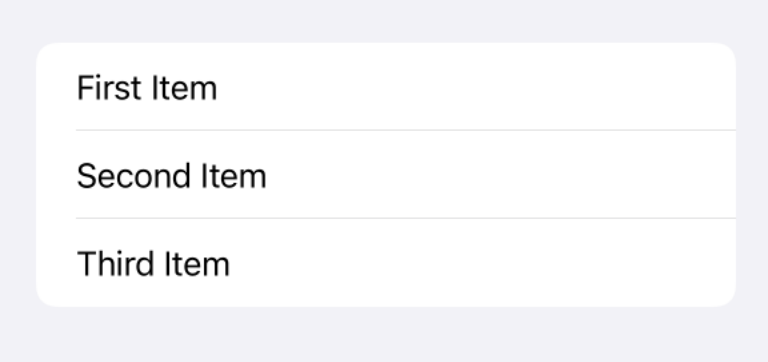
```
struct Collections_3_1: View {
    var body: some View {
        List {
            Text("Item One")
            Text("Item Two")
            Text("Item Three")
        }
    }
}
```



List Views – 2

- You can nest a `ForEach` to populate a scrollable list based on a collection of values:

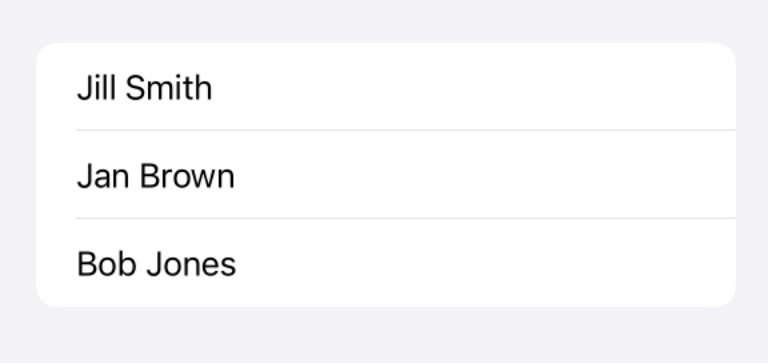
```
struct Collections_3: View {
    let strings = ["First Item", "Second Item", "Third Item"]

    var body: some View {
        List {
            ForEach(strings, id: \.self) { string in
                Text(string)
            }
        }
    }
}
```



List Views – 3

- You can also use a `List` without a nested `ForEach`.

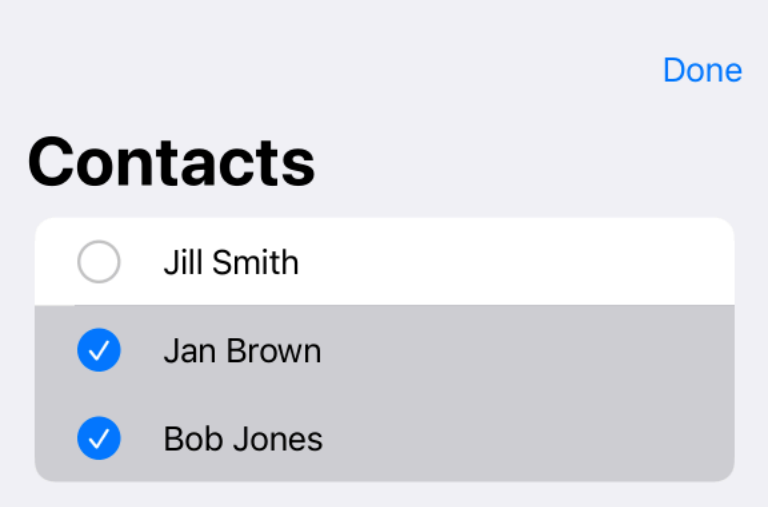
```
let contacts: [Contact] = [
    Contact(name: "Jill Smith"),
    Contact(name: "Jan Brown"),
    Contact(name: "Bob Jones"),
]

struct Collections_4: View {
    var body: some View {
        List(contacts) { contact in
            Text(contact.name)
        }
    }
}
```



List Views – 4

- Lists come with built-in support for single and multiple selection.
- For multiple selection, bind the selection initializer argument to a `Set` generically typed to the type of the model object's `id` property.

```
struct Collections_4_1: View {
    @State private var selections: Set<UUID> = []

    var body: some View {
        NavigationView {
            List(contacts, selection: $selections) { contact in
                Text(contact.name)
            }
            .navigationTitle("Contacts")
            .toolbar { EditButton() }
        }
    }
}
```



Section 5: Navigation and Modal Presentation

Presenting a Sheet

- There are two pairs of view modifiers for presenting a sheet temporarily on screen. One of the pairs is shown below.
- What differs is the first parameter, which is used to toggle presentation.
- In other words, you can either use an optional or a boolean to determine whether the sheet is currently shown.

```
func sheet<Content>(
    isPresented: Binding<Bool>,
    onDismiss: (() -> Void)? = nil,
    @ViewBuilder content: @escaping () -> Content) -> some View where Content : View

func sheet<Item, Content>(
    item: Binding<Item?>,
    onDismiss: (() -> Void)? = nil,
    @ViewBuilder content: @escaping (Item) -> Content) -> some View where Item :
Identifiable, Content : View
```

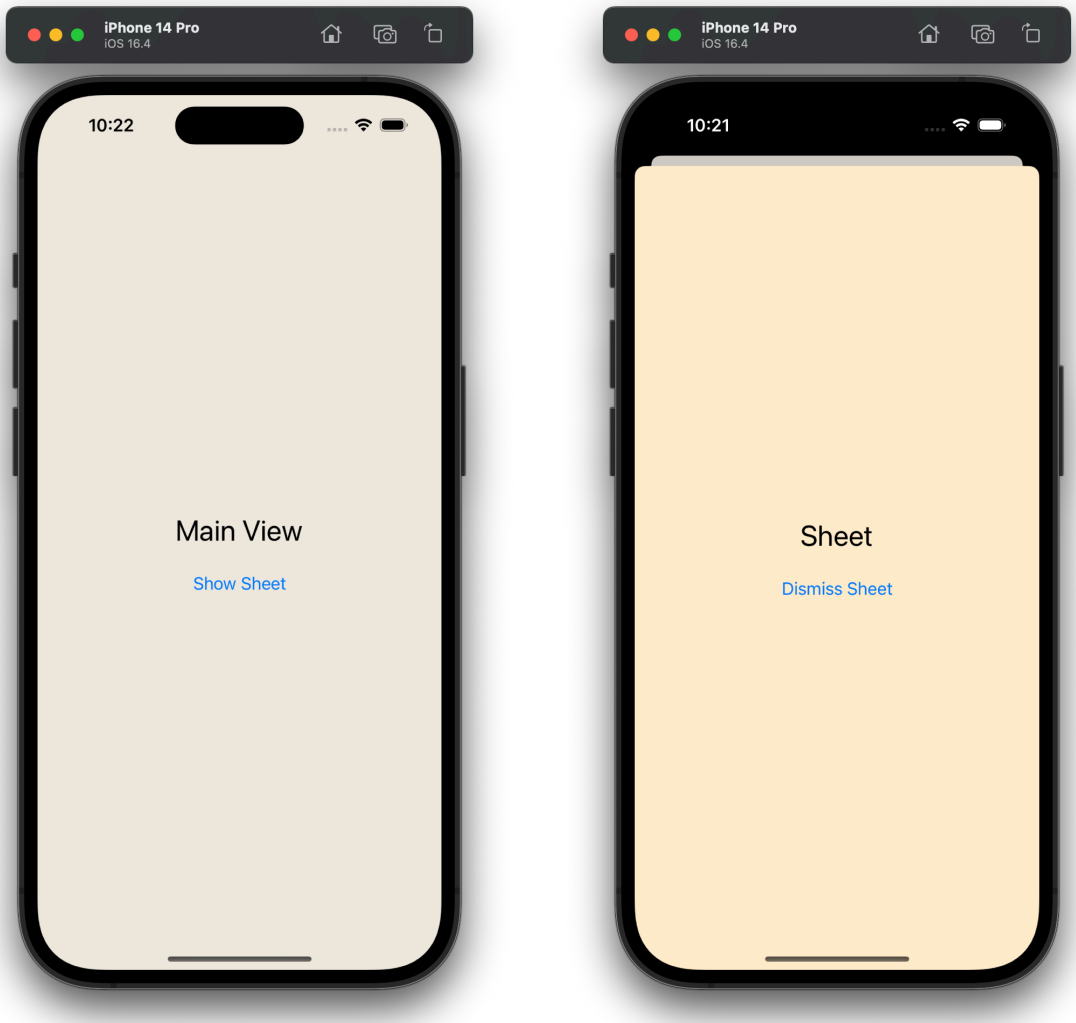
- The other pair of view modifiers take the same arguments, but substitute the function name `fullScreenCover` for `sheet`.
- As the name suggests, the former presents a sheet covering the entire screen, whereas the latter is presented in a card-style interface.

Sheet Example – 1

```
struct Sheets_1: View {
    @State private var isShowingSheet = false

    var body: some View {
        VStack {
            TitledButton(title: "Main View",
                         action: showSheet,
                         label: "Show Sheet",
                         backgroundColor: .brown)
        }
        .sheet(isPresented: $isShowingSheet) {
            TitledButton(title: "Sheet",
                         action: dismissSheet,
                         label: "Dismiss Sheet",
                         backgroundColor: .orange)
        }
    }

    private func showSheet() {
        isShowingSheet = true
    }

    private func dismissSheet() {
        isShowingSheet = false
    }
}

struct TitledButton: View {
    let title: String
    let action: () -> Void
    let label: String
    let backgroundColor: Color

    var body: some View {
        VStack() {
            Text(title)
                .padding()
                .font(.title)
            Button(action: action, label: { Text(label) })
        }
        .frame(maxWidth: .infinity, maxHeight: .infinity)
        .background(backgroundColor.opacity(0.2))
    }
}
```

Sheet Example – 2

Presenting a Sheet



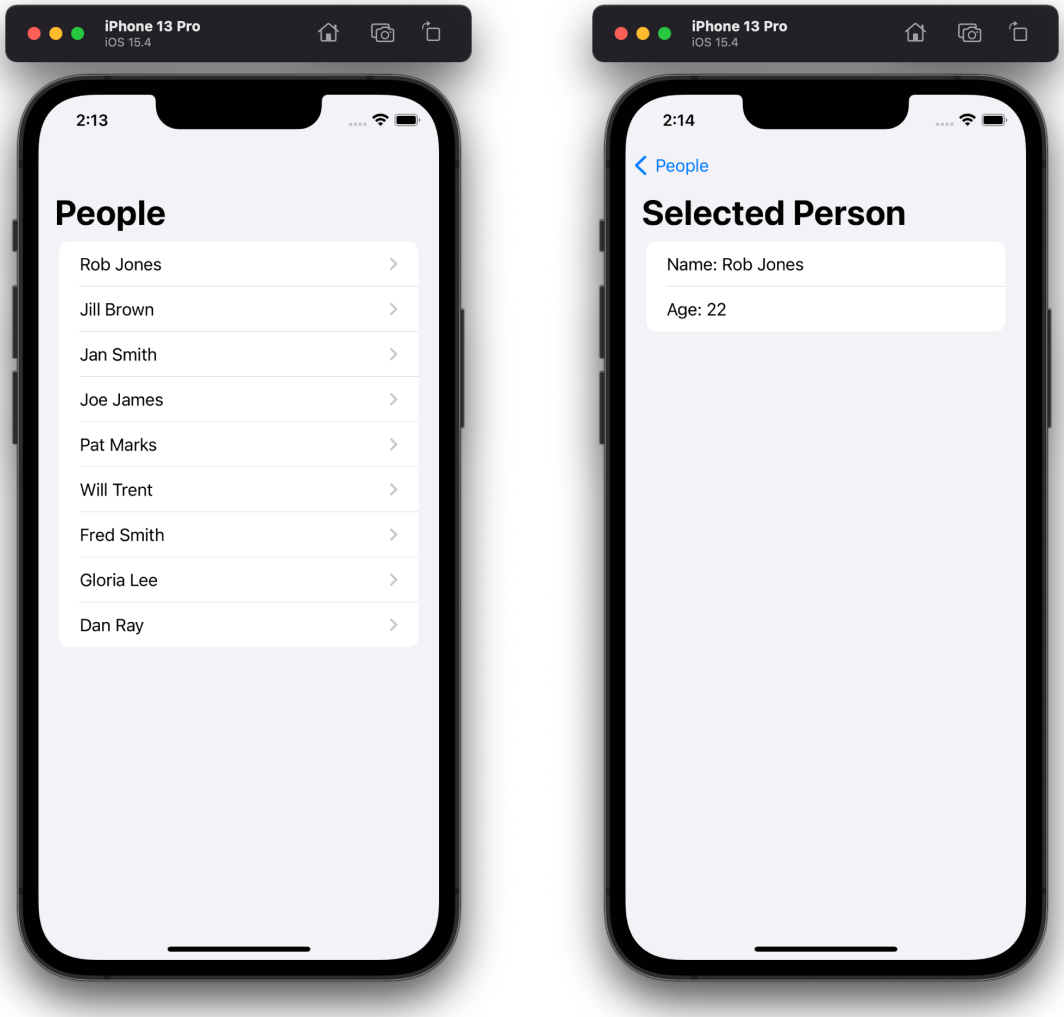
Navigation Stacks

- A `NavigationStack` wraps its content with a navigation bar and provides navigation behavior on behalf of its nested view.
- To implement navigation, include one or more instances of `NavigationLink` inside the navigation view's content.
- Nested container views can add a `navigationTitle(:_)` modifier to provide a title to be presented in the navigation bar
- (Note that a navigation stack's content doesn't have to be a `List`, though that's what's shown in the following example.)

```
struct Navigation_1: View {
    @StateObject private var viewModel = PeopleViewModel()

    var body: some View {
        NavigationStack {
            List(viewModel.people, id: \.name) { person in
                NavigationLink(person.name) {
                    Form {
                        Text("Name: \(person.name)")
                        Text("Age: \(person.age)")
                    }
                    .navigationTitle("Selected Person")
                }
            }
            .navigationTitle("People")
        }
    }
}
```

Navigation Example

A Navigation Stack with Navigation Links



Toolbars

- Use the `toolbar(_:)` view modifier to add content to the navigation bar.
- You can directly add items such as buttons, but for more control, nest the items in instances of ToolbarItem, which will allow you to specify each item's placement.
- (Note that you will need a `ForEach` to support editing a list, as shown in the example.)

Toolbars Example

```
struct Navigation_2: View {
    @StateObject private var viewModel = PeopleViewModel()
    var body: some View {
        NavigationView {
            List {
                ForEach(viewModel.people, id: \.name) { person in
                    NavigationLink(person.name) {
                        PersonCell(person: person)
                    }
                }
                .onDelete { indexSet in
                    delete(at: indexSet)
                }
            }
            .navigationTitle("People")
            .toolbar {
                ToolbarItem {
                    EditButton()
                }
                ToolbarItem(placement: .navigationBarLeading) {
                    Button(action: {}, label: { Image(systemName: "plus.circle") })
                }
            }
        }
    }

    private func add() { // ... }
    private func delete(at indexSet: IndexSet) {
        viewModel.people.remove(at: indexSet.first ?? 0)
    }
}

struct PersonCell: View {
    let person: Person
    var body: some View {
        Form {
            Text("Name: \(person.name)")
            Text("Age: \(person.age)")
        }
        .navigationTitle("Selected Person")
    }
}
```

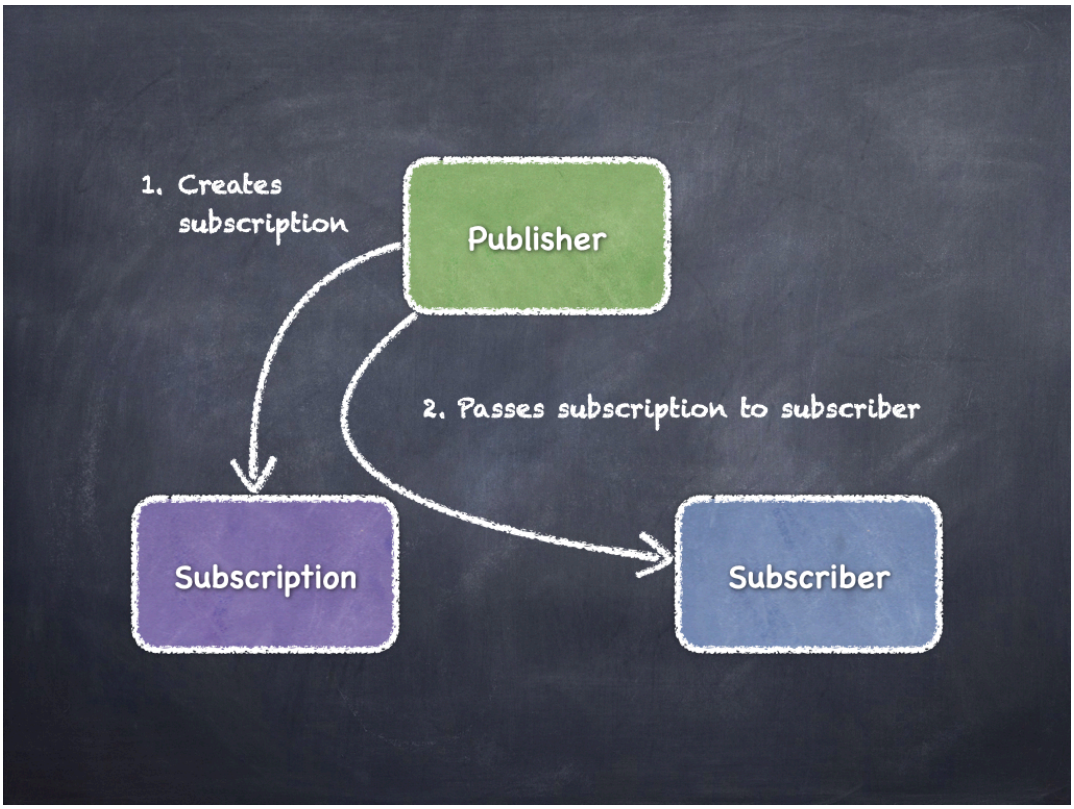
Section 6: Concurrency

Overview

- The `Publisher` protocol declares the API for objects that deliver values over time. That allows you to work with the values in a fashion similar to working with a collection.
- Publishers have methods, termed *operators*, that allow them to be chained together, to control the flow of data and perform transformations, as needed.
- Subscribers (objects conforming to the `Subscriber` protocol) sit at the end of a chain of publishers and act upon the resulting values.
- Note that a publisher only emits values when requested by a subscriber, giving your code control over the pace of the data flow.
- Several framework types expose publishers through their API, including `Timer`, `NotificationCenter`, and `URLSession`.

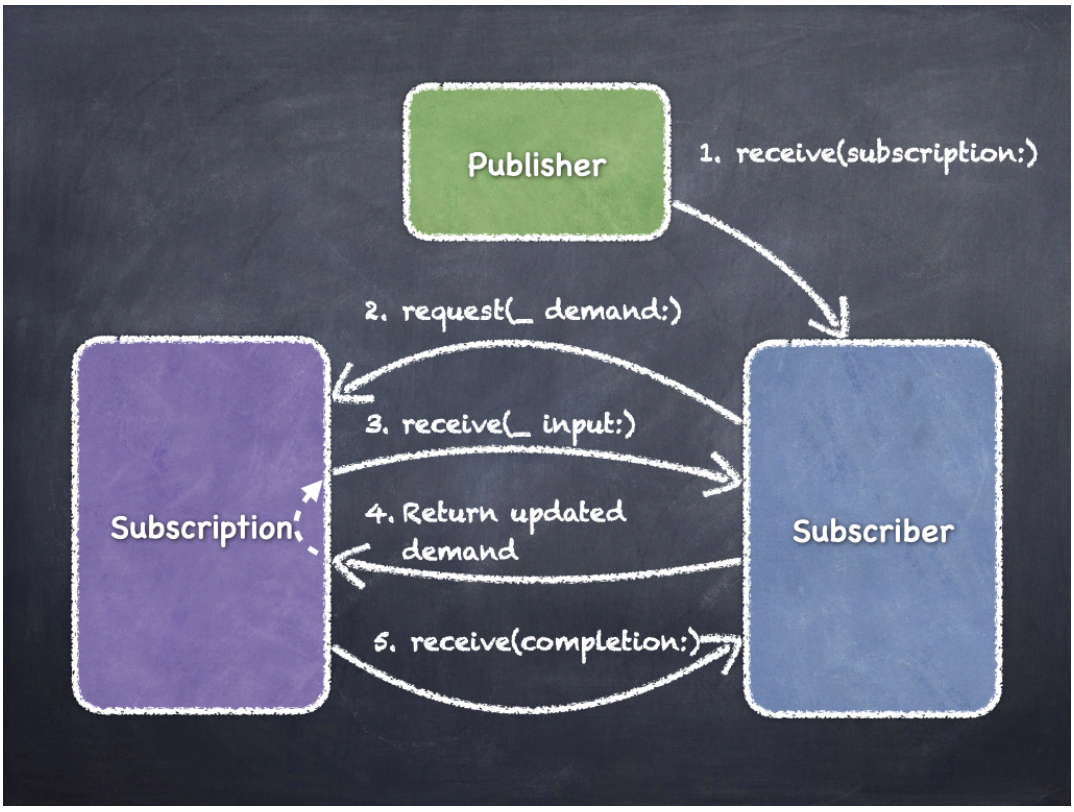
Publishers and Subscribers

- A publisher creates a subscription that 'pushes' one or more values to a subscriber.
- The publisher passes the subscriber to the subscription to establish a connection.
- The subscriber also receives a reference to the subscription. *This is important because the subscription must be stored in a property in order to keep it alive.*



Subscriptions

- A subscriber requests values from its subscription, passing an initial demand (i.e. how many values it wishes to receive)
- The subscription then calls the subscriber's `receive(_:)` method as many times as necessary (based on demand).
- When finished, the subscription calls the subscriber's `receive(completion:)` method.



Using the sink Operator

- You can use the `sink(receiveCompletion:receiveValue:)` operator to subscribe to a publisher — for example an `@Published` property.
- Note that the return value is a subscription, which must be stored to allow for later cancellation. *If the subscription isn't stored, it's cancelled immediately.*

```
import SwiftUI
import Combine

final class PersonViewModel_4: ObservableObject {
    @Published var person: Person = Person(name: "Fred Smith",
                                           age: 32)

    private var subscriptions: Set<AnyCancellable> = []

    init() {
        $person
            .sink { person in
                print(person.name)
            }
            .store(in: &subscriptions)
    }
}
```

Chaining a map Operator

- The code below adds a `name` published property to the previous example to allow the Combine operators to work directly with the stream of text.
- It also inserts a `map(_:)` operator in the chain to modify the text on the fly, and then store it back in the `uppercasedName` property.
- The `debounce(for:scheduler:)` operator sets a minimum time period before a publisher can emit an event.

```
final class PersonViewModel_4_1: ObservableObject {
    @Published var person: Person = Person(name: "Jan Brown", age: 33)
    @Published var name: String = "" {
        didSet { person.name = name }
    }
    @Published var uppercasedName: String = ""

    private var subscriptions: Set<AnyCancellable> = []

    init() {
        name = person.name

        $name
            .debounce(for: 1, scheduler: RunLoop.main)
            .map { text in
                text.uppercased()
            }
            .sink { text in
                self.uppercasedName = text
            }
            .store(in: &subscriptions)
    }
}
```

Structured Concurrency

- Structured concurrency is a new set of technologies in Swift that provide support for async/await and Actors.
- Its goal is to simplify and streamline code that deals with concurrency, while helping developers avoid data races by using tasks as the fundamental unit of concurrency.
- Tasks created via `async let` or task groups are child tasks of an originating task, and can't outlive their parent's lifetime. This provides scoping around concurrency, and thus structure.
- The keyword `await` defines a suspension point. A call to an async function must be annotated with `await`. A function that can can suspend must be annotated with `async`.
- Compare the code below with the Combine unit test example.

```
func testFetchQuotesWithAsyncAwait() async throws {
    let req = URLRequest(url: url)
    let (data, response) = try await URLSession.shared.data(for: req)

    if let wrapper = try? JSONDecoder().decode(QuotesWrapper.self,
                                               from: data) {
        print(response, "\n", wrapper.quotes)
        XCTAssertFalse(wrapper.quotes.isEmpty)
    } else {
        XCTFail("Unable to fetch quotes from url \(url)")
    }
}
```