Hacking with iOS - SwiftUI

# Project 01 – WeSplit

Some notes about creating a new SwiftUI project:

* Example of how to create a basic project:
* For Product Name please enter the name of the project, like “WeSplit”.
* For Organization Identifier you can enter whatever you want, but if you have a website you should enter it with the components reversed: “hackingwithswift.com” would be “com.hackingwithswift”. If you don’t have a domain, make one up – “me.yourlastname.yourfirstname” is perfectly fine.
* For Interface please select SwiftUI.
* For Language please make sure you have Swift selected.
* Make sure all the checkboxes at the bottom are not checked.
* When creating a new project, you can check the target iOS by selecting the project in the project navigation bar, the one at the top, select Project list, and you can see the iOS Deployment Target, also if you select the Targets list, you can see the minimum Deployments target.

These are some of the files that are created by default, following the example:

* The WeSplitApp.swift contains code for launching your app.
* ContentView.swift contains the initial user interface for your program.
* Assets.xcassets is an asset catalog.
* Preview Content is a group with preview assets, another catalog, for example, for images you want to use when you’re designing your UI, to have an idea of how they might look.

The ContentView.swift file has a default code like this:

**import** SwiftUI

**struct** ContentView: View {

**var** body: **some** View {

VStack {

Image(systemName: "globe")

.imageScale(.large)

.foregroundColor(.accentColor)

Text("Hello, world!")

}

.padding()

}

}

**struct** ContentView\_Previews: PreviewProvider {

**static** **var** previews: **some** View {

ContentView()

}

}

The View protocol has one requirement: to have a computed property called body that returns some View.

The padding method is also called a modifier. They are like regular methods but they return a new view that contains both your original data plus the extra modification you asked for.

The ContentView struct won’t be part of the final app that goes to the App Store, it is specifically for Xcode to use so it can show a preview of your UI design.

With the preview of the UI visible, press Option+Cmd+P to update the canvas.

If you need to add more than 10 elements in a Form you can use Groups. Groups don’t actually change the way your user interface looks, they just let us work around SwiftUI’s limitation of ten child views inside a parent.

If you want your form to look different when splitting items into chunks, you should use the Section view instead. This splits your form into discrete visual groups, just like the Settings app does.

## Navigation Bar

By default SwiftUI ensures components are placed in an area where they can’t be covered up by system UI or device rounded corners – an area known as the safe area.

If you have a Form and you swipe around in the simulator, you will find you can move the row up so it goes under the clock. You can fix this by using a navigation bar. Example:

**import** SwiftUI

**struct** ContentView: View {

**var** body: **some** View {

NavigationView {

Form {

Section {

Text("Hello, world!")

}

}

.navigationTitle("SwiftUI")

.navigationBarTitleDisplayMode(.inline)

}

}

}

navigationTitle: add a navigation title, this uses a large font.

navigationBarTitleDisplayMode allows you to get a small font for the navigation bar.

## Modifying Program State

SwiftUI’s views are a function of their state, that means that the way your user interface looks – the things people can see and what they can interact with – are determined by the state of your program. For example, they can’t tap Continue until they have entered their name in a text field.

When creating struct methods that want to change properties, we need to add the mutating keyword: **mutating func doSomeWork()**, for example. However, Swift doesn’t let us make mutating computed properties, which means we can’t write **mutating var body: some View** – it just isn’t allowed.

Fortunately, Swift gives us a special solution called a *property wrapper*: a special attribute we can place before our properties that effectively gives them super-powers. In the case of storing simple program state like the number of times a button was tapped, we can use a property wrapper from SwiftUI called **@State**, like this:

**struct** ContentView: View {

@State private **var** tapCount = 0

**var** body: **some** View {

Button("Tap Count: \(tapCount)") {

**self**.tapCount += 1

}

}

}

**@State** allows us to work around the limitation of structs: we know we can’t change their properties because structs are fixed, but **@State** allows that value to be stored separately by SwiftUI in a place that *can* be modified.

There are several ways of storing program state in SwiftUI, and you’ll learn all of them. **@State** is specifically designed for simple properties that are stored in one view. As a result, Apple recommends we add **private** access control to those properties, like this: **@State private var tapCount = 0**.

## Binding State to User Interface Controls

Views are a function of their state – that text field can only show something if it reflects a value stored in your program. What SwiftUI wants is a string property in our struct that can be shown inside the text field, and will also store whatever the user types in the text field.

In the case of a text field to handle a name, Swift needs to make sure whatever is in the text is also in the **name** property, so that it can fulfill its promise that our views are a function of their state – that everything the user can see is just the visible representation of the structs and properties in our code.

This is what’s called a *two-way binding*: we bind the text field so that it shows the value of our property, but we also bind it so that any changes to the text field also update the property.

In Swift, we mark these two-way bindings with a special symbol so they stand out: we write a dollar sign before them. This tells Swift that it should read the value of the property but also write it back as any changes happen.

**struct** ContentView: View {

@State **private** **var** name = ""

**var** body: **some** View {

TextField("Enter your name", text: $name)

Form {

Text("Hello, \(name)")

}

}

}

## Creating views in a loop

In SwiftUI you have the ForEach to loop over arrays and ranges , creating as many views as needed. Example:

Form {

ForEach(0..<100) { number in

Text("Row \(number)")

}

}

We can use shorthand syntax for the parameter name:

Form {

ForEach(0 ..< 100) {

Text("Row \($0)")

}

}

// 1. Has an array of possible student names.

// 2. Has an @State property storing the currently selected student.

// 3. Creates a Picker view asking users to select their favorite, using a two-way binding to the @State property.

// 4. Uses ForEach to loop over all possible student names, turning them into a text view.

//

**import** SwiftUI

**struct** ContentView: View {

**let** students = ["Harry", "Hermione", "Ron"]

@State **private** **var** selectedStudent = "Harry"

**var** body: **some** View {

NavigationView {

Form {

Picker("Select your student", selection: $selectedStudent){

ForEach(students, id: \.**self**){

Text($0)

}

}

}

}

}

}

## Reading text from the user in TextField

When you need to have text fields for double values, you can add a format to the TextField to use Locale (Locale is a massive struct built into iOS that is responsible for storing all the user’s region settings – what calendar they use, how they separate thousands digits in numbers, whether they use the metric system, and more). But you can also use the keyboardType with .decimalPad to limit the user to enter just numeric values:

Form {

Section{

TextField("Amount", value: $checkAmount,

format: .currency(code: Locale.current.currency?.identifier ?? "USD"))

.keyboardType(.decimalPad)

}

Section{

Text(checkAmount, format: .currency(code: Locale.current.currency?.identifier ?? "USD"))

}

}

One of the great things about the **@State** property wrapper is that it automatically watches for changes, and when something happens it will automatically re-invoke the **body** property.

This synchronization happens because:

1. Our text field has a two-way binding to the checkAmount property.

2. The checkAmount property is marked with @State, which automatically watches for

changes in the value.

3. When an @State property changes SwiftUI will re-invoke the body property (i.e., reload

our UI)

4. Therefore the text view will get the updated value of checkAmount.

## Creating pickers in a Form

SwiftUI’s pickers serve multiple purposes, and exactly how they look depends on which device you’re using and the context where the picker is used.

The value of a picker is in fact an index.

**struct** ContentView: View {

@State **private** **var** checkAmount = 0.0

@State **private** **var** numberOfPeople = 2

@State **private** **var** tipPercentage = 20

**let** tipPercentages = [10, 15, 20, 25, 0]

**var** body: **some** View {

VStack {

NavigationView {

Form {

Section{

TextField("Amount", value: $checkAmount,

format: .currency(code: Locale.current.currency?.identifier ?? "USD"))

.keyboardType(.decimalPad)

}

Picker("Number of people", selection: $numberOfPeople){

ForEach(2 ..< 100){

Text("\($0) people")

}

}

}

.navigationTitle("We Split")

}

}

.padding()

}

}

## Adding a segmented control for tip percentages

A segmented control is a specialized kind of picker that shows a handful of options in a horizontal list, and it works great when you have only a small selection to choose from.

SwiftUI lets us add views to the header and footer of a section, which in this instance we can use to add a small explanatory prompt.

Section {

Picker("Tip percentage", selection: $tipPercentage) {

ForEach(tipPercentages, id: \.**self**) {

Text($0, format: .percent)

}

}

.pickerStyle(.segmented)

} header: {

Text("How much tip do you want to leave?")

}

## Calculating the total per person

We can create properties, for example, a property called totalPerPerson where we can calculate the amount to pay per person according to the values selected and entered in the other properties:

// Property that calculates the total per person

**var** totalPerPerson: Double {

// The picker starts with 2, so we need to add 2 to the value

**let** peopleCount = Double(numberOfPeople + 2)

**let** tipSelection = Double(tipPercentage)

**let** tipValue = checkAmount / 100 \* tipSelection

**let** grandTotal = checkAmount + tipValue

**let** amountPerPerson = grandTotal / peopleCount

**return** amountPerPerson

}

This one can be displayed in the Text view below:

Section{

Text(totalPerPerson,

format: .currency(code: Locale.current.currency?.identifier ?? "USD"))

}

## Hiding the keyboard

To hide the keyboard:

1. We need to give SwiftUI some way of determining whether the check amount box should currently have focus – should be receiving text input from the user.
2. We need to add some kind of button to remove that focus when the user wants, which will in turn cause the keyboard to go away.

To solve the first one you need to meet your second property wrapper: @FocusState. This is exactly like a regular @State property, except it’s specifically designed to handle input focus in our UI.

For example, you can create a property like this:

@FocusState **private** **var** amountIsFocused: Bool

And attach it to the text field with the modifier focused:

TextField("Amount", value: $checkAmount,

format: .currency(code: Locale.current.currency?.identifier ?? "USD"))

.keyboardType(.decimalPad)

.focused($amountIsFocused)

The second part of our solution is to add a toolbar to the keyboard when it appears, so we can place a Done button in there. To make this work really well you need to meet several new SwiftUI views:

.toolbar {

ToolbarItemGroup(placement: .keyboard) {

Button("Done") {

amountIsFocused = **false**

}

}

This is a modifier to be applied to the Form.

1. The toolbar() modifier lets us specify toolbar items for a view. These toolbar items might appear in various places on the screen – in the navigation bar at the top, in a special toolbar area at the bottom, and so on.
2. ToolbarItemGroup lets us place one or more buttons in a specific location, and this is where we get to specify we want a keyboard toolbar – a toolbar that is attached to the keyboard, so it will automatically appear and disappear with the keyboard.
3. The Button view we’re using here displays some tappable text, which in our case is “Done”. We also need to provide it with some code to run when the button is pressed, which in our case sets amountIsFocused to false so that the keyboard is dismissed.

The complete code looks like this:

**import** SwiftUI

**struct** ContentView: View {

@State **private** **var** checkAmount = 0.0

@State **private** **var** numberOfPeople = 2

@State **private** **var** tipPercentage = 20

@FocusState **private** **var** amountIsFocused: Bool

**let** tipPercentages = [10, 15, 20, 25, 0]

// Property that calculates the total per person

**var** totalPerPerson: Double {

// The picker starts with 2, so we need to add 2 to the value

**let** peopleCount = Double(numberOfPeople + 2)

**let** tipSelection = Double(tipPercentage)

**let** tipValue = checkAmount / 100 \* tipSelection

**let** grandTotal = checkAmount + tipValue

**let** amountPerPerson = grandTotal / peopleCount

**return** amountPerPerson

}

**var** body: **some** View {

VStack {

NavigationView {

Form {

Section{

TextField("Amount", value: $checkAmount,

format: .currency(code: Locale.current.currency?.identifier ?? "USD"))

.keyboardType(.decimalPad)

.focused($amountIsFocused)

Picker("Number of people", selection: $numberOfPeople){

ForEach(2 ..< 100){

Text("\($0) people")

}

}

}

Section {

Picker("Tip percentage", selection: $tipPercentage) {

ForEach(tipPercentages, id: \.**self**) {

Text($0, format: .percent)

}

}

.pickerStyle(.segmented)

} header: {

Text("How much tip do you want to leave?")

}

Section{

Text(totalPerPerson,

format: .currency(code: Locale.current.currency?.identifier ?? "USD"))

}

}

.navigationTitle("We Split")

.toolbar {

ToolbarItemGroup(placement: .keyboard) {

Spacer()

Button("Done") {

amountIsFocused = **false**

}

}

}

}

}

.padding()

}

}

**struct** ContentView\_Previews: PreviewProvider {

**static** **var** previews: **some** View {

ContentView()

}

}

# Project 02 – Guess the Flag

## Using stacks to arrange views

When we return some View for our body, SwiftUI expects to receive back some kind of view that can be displayed on the screen. That might be a navigation view, a form, a text view, a picker, or something else entirely, but it must conform to the View protocol so that it can be drawn on the screen.

If we want to return multiple things we have various options, but three are particularly useful. They are HStack, VStack, and ZStack, which handle horizontal, vertical, and, er, zepth.

The previous stacks allow a maximum of 10 views as well, so if you need to have more items, you will need to group them using other stacks. The VStack and HStack have some properties like spacing or alignment that allow you to modify the way the views inside are displayed. For Example:

**var** body: **some** View {

VStack (alignment: .leading, spacing: 20) {

Text("Hello, world!")

Text("This is another text view!")

}

}

You can also use Spacer(), that is a kind of view to add some space between other views.

In the ZStack, you don’t have spacing property, but you can use alignment.

## Colors and Frames

When using stacks, if you do something like this:

ZStack {

Text("Your content")

}

.background(.red)

You will see the are painted in red, is just the text, because the stacks take fit their content. You can use Color.red which will take the whole screen size and it is a view by itself, but you can also use a frame to limit the width and height.

ZStack {

Color.red

.frame(width: 200, height: 200)

Text("Your content")

}

You can also specify minimum and maximum widths and heights, depending on the layout you want. For example: we could say we want a color that is no more than 200 points high, but for its width must be at least 200 points wide but can stretch to fill all the available width that’s not used by other stuff:

ZStack {

Color.red

.frame(minWidth: 200, maxWidth: .infinity, maxHeight: 200)

Text("Your content")

}

Beyond red, green and other colors, you can use semantic color, like primary, secondary, that refers to the text color. You can also use custom colors:

Color.primary

Color(red: 1, green: 0.8, blue: 0)

By default, the colors don’t include the safe area (the top and bottom parts of the screen. You can indicate to ignore the safe area.

ZStack {

Color.red

Text("Your content")

}

.ignoresSafeArea()

Keep anything important inside the safe area.

SwiftUI gives us an alternative for the foreground color that provides a very slightly different effect: change the foregroundColor() modifier to foregroundStyle().

## Gradients

SwiftUI gives us three kinds of gradients to work with. Gradients are made up of several components:

• An array of colors to show

• Size and direction information

• The type of gradient to use

LinearGradient(gradient: Gradient(colors: [.white, .black]),

startPoint: .top, endPoint: .bottom)

You can use stoppers to specify both a color and how far along the gradient the color should be used:

LinearGradient(gradient: Gradient(stops: [

Gradient.Stop(color: .white, location: 0.45),

Gradient.Stop(color: .black, location: 0.55),

]), startPoint: .top, endPoint: .bottom)

As an alternative, radial gradients move outward in a circle shape, so instead of specifying a direction we specify a start and end radius – how far from the center of the circle the color should start and stop changing. For example:

RadialGradient(gradient: Gradient(colors: [.blue, .black]),

center: .center, startRadius: 20, endRadius: 200)

The last gradient type is called an angular gradient, although you might have heard it referred to elsewhere as a conic or conical gradient.

AngularGradient(gradient: Gradient(colors: [.red, .yellow, .green, .blue, .purple, .red]), center: .center)

## Buttons and Images

The buttons allow you to execute some actions in different ways, for example:

**struct** ContentView: View {

**var** body: **some** View {

VStack{

Button("Delete selection") {

print("Now deleting...")

}

//Call a function when click the button

Button("Delete Items", action: executeDelete)

}

}

**func** executeDelete(){

print("Now deleting...")

}

}

You can also give some style to the buttons with some predefined properties, like buttonStyle and role:

VStack {

Button("Button 1") { }

.buttonStyle(.bordered)

Button("Button 2", role: .destructive) { }

.buttonStyle(.bordered)

Button("Button 3") { }

.buttonStyle(.borderedProminent)

.tint(.mint)

Button("Button 4", role: .destructive) { }

.buttonStyle(.borderedProminent)

}

You can customize the button, like this, showing a label with different properties:

Button {

print("Button was tapped")

} label: {

Text("Tap me!")

.padding()

.foregroundColor(.white)

.background(.red)

}

You can add images using some built-in assets catalog images. For example:

Image(systemName: "pencil")

You can use them as decorative images for the buttons.

Button {

print("Button was tapped")

} label: {

Label("Edit", systemImage: "pencil")

}

## Showing Alert Messages

In SwiftUI you create the alert and set the conditions under which it should be shown.

A basic SwiftUI alert has a title and a button that dismisses it, but the more interesting part is how we present that alert: we don’t assign the alert to a variable then write something like myAlert.show(), because that would be back to the old “series of events” way of thinking.

Instead, we create some state that tracks whether our alert is showing, like this:

@State private var showingAlert = false

We then attach our alert somewhere to our user interface, telling it to use that state to determine whether the alert is presented or not. SwiftUI will watch showingAlert, and as soon as it becomes true it will show the alert.

**struct** ContentView: View {

@State **private** **var** showingAlert = **false**

**var** body: **some** View {

VStack {

Button ("Show Alert"){

showingAlert = **true**

}.alert("Important message", isPresented: $showingAlert){

Button("OK"){ }

}

}

}

}

In the previous example, the isPresented property is bound to the showingAlert property, this way, when the value of the showingAlert changes, it will present the alert.

Any button insider the alert will dismiss the alert.

You can add as many buttons as you need and user roles for them:

@State **private** **var** showingAlert = **false**

**var** body: **some** View {

VStack {

Button ("Show Alert"){

showingAlert = **true**

}.alert("Important message", isPresented: $showingAlert){

Button("Delete", role: .destructive){ }

Button("Cancel", role: .cancel) {}

} message: {

Text("Please read this")

}

}

}

## Notes from Project

When you have several asset images, you just need to select the Assets.xcassets in the project and drag and drop the images there.

.shuffled() method can be used in an array to shuffle or re-arranged the items.

The **renderingMode(.original)** modifier tells SwiftUI to render the original image pixels rather than trying to recolor them as a button.

We can control the size and style of text using the font() modifier, which lets us select from one of the built-in font sizes on iOS. As for adjusting the weight of fonts – whether we want super-thing text, slightly bold text, etc – we can get fine-grained control over that by adding a weight() modifier to whatever font we ask for.

For the flags, and for any other view you can give a number of modifiers to affect the way views are presented, and we’re going to use two here: one to change the shape of flags, and one to add a shadow.

Making our image capsule shaped is as easy as adding the .clipShape(Capsule()) modifier, like this:

.clipShape(Capsule())

The final code is this:

**import** SwiftUI

**struct** ContentView: View {

@State **private** **var** showingScore = **false**

@State **private** **var** scoreTitle = ""

@State **private** **var** userScore = 0

@State **private** **var** questionsCount = 1

@State **private** **var** countries = ["Estonia", "France", "Germany", "Ireland", "Italy", "Nigeria",

"Poland", "Russia", "Spain", "UK", "US"].shuffled()

@State **private** **var** correctAnswer = Int.random(in: 0...2)

@State **private** **var** showingAlert = **false**

@State **private** **var** showingResultAlert = **false**

**var** body: **some** View {

ZStack {

RadialGradient(stops: [

.init(color: Color(red: 0.1, green: 0.2, blue: 0.45), location: 0.3),

.init(color: Color(red: 0.76, green: 0.15, blue: 0.26), location: 0.3)

], center: .top, startRadius: 200, endRadius: 700)

.ignoresSafeArea()

VStack{

Spacer()

Text("Guess the Flag")

.font(.largeTitle.weight(.bold))

.foregroundColor(.white)

VStack(spacing: 15){

VStack {

Text("Tap the flag of")

.foregroundStyle(.secondary)

.font(.subheadline.weight(.heavy))

Text(countries[correctAnswer])

.font(.largeTitle.weight(.semibold))

}

ForEach(0..<3){number **in**

Button {

flagTapped(number)

} label: {

Image(countries[number])

.renderingMode(.original)

.clipShape(Capsule())

.shadow(radius: 5)

}

}

}

.frame(maxWidth: .infinity)

.padding(.vertical, 20)

.background(.regularMaterial)

.clipShape(RoundedRectangle(cornerRadius: 20))

Spacer()

Spacer()

Text("Score: \(userScore)")

.foregroundColor(.white)

.font(.title.bold())

Spacer()

}

.padding()

}

.alert(scoreTitle, isPresented: $showingScore){

Button("Continue", action: askQuestion)

} message: {

Text("Your score is \(userScore)")

}

.alert("Results", isPresented: $showingResultAlert){

Button("Restart the Game", action: resetGame)

} message: {

Text("Your final score is \(userScore)")

}

}

**func** flagTapped(\_ number: Int){

**if** number == correctAnswer {

scoreTitle = "Correct"

userScore += 1

} **else** {

scoreTitle = "Wrong! That's the flag of \(countries[number])"

}

showingScore = **true**

questionsCount += 1

**if** questionsCount == 9 {

showingResultAlert = **true**

}

}

**func** askQuestion() {

countries.shuffle()

correctAnswer = Int.random(in: 0...2)

}

**func** resetGame(){

userScore = 0

questionsCount = 1

showingScore = **false**

askQuestion()

}

}

**struct** ContentView\_Previews: PreviewProvider {

**static** **var** previews: **some** View {

ContentView()

}

}

Some important things to remember:

* The Spacers allow you to add spaces to segment the elements in a VStack or HStack
* There are some predefined modifiers for the text elements, like foregroundStyle(.secondary) of .subheadline.bold()
* A button can have an image that fits the entire button or just a part along with a text.
* To keep the original color of the image in a button, use .renderingMode(.original)
* You can give different shapes to a view using clipShape
* You can use different properties to modify how to display a view, like .frame or .padding and .background.
* An alert uses the isPresented to know when it should be displayed.
* An Alert can have as many buttons as you need.
* You can define methods inside a Struct

# Project 03 – Views and Modifiers

## Why does SwiftUI use structs for views?

There are several reasons why in SwiftUI we use structs instead of classes:

1. Performance: Structs are simpler and faster than classes. In UIKit, every view descended from a class called UIView that had many properties and methods. There were lots of these, and every UIView and UIView subclass had to have them, because that’s how inheritance works. As structs cannot inherit, they contain what you see and nothing more, it doesn’t load anything more.
2. Structs forces us to think about isolating state in a clean way. SwiftUI encourages us to move to a more functional design approach: our views become simple, inert things that convert data into UI, rather than intelligent things that can grow out of control.

## What’s behind the main SwiftUI view?

This if the starting code you see when working with SwiftUI:

struct ContentView: View {

var body: some View {

Text("Hello, world!")

.padding()

}

}

You should try to get into the mindset that there is nothing behind our view – that what you see is all we have.

Now, right now at least there is something behind our content view called a UIHostingController: it is the bridge between UIKit (Apple’s original iOS UI framework) and SwiftUI. However, if you start trying to modify that you’ll find that your code no longer works on Apple’s other platforms, and in fact might stop working entirely on iOS at some point in the future.

One way, for example, to make the Text view to use all the available space and color it red, is this:

Text("Hello, world!")

.frame(maxWidth: .infinity, maxHeight: .infinity)

.background(.red)

## Why modifiers order matters?

Whenever we apply a modifier to a SwiftUI view, we actually create a new view with that change applied – we don’t just modify the existing view in place.

You can peek into the underbelly of SwiftUI by asking for the type of our view’s body. Modify the button to this:

Button("Hello, world!") {

print(type(of: self.body))

}

.background(.red)

.frame(width: 200, height: 200)

Swift’s type(of:) method prints the exact type of a particular value, and in this instance it will print the following:

ModifiedContent<ModifiedContent<Button<Text>, \_BackgroundStyleModifier<Color>>, \_FrameLayout>

So, if you have a code like this:

Text("Hello, world!")

.padding()

.background(.red)

.padding()

.background(.blue)

.padding()

.background(.green)

.padding()

.background(.yellow)

You will see how every color is stack up over the color defined before.

## Why SwiftUI use “some View” for its type?

The “some View” allow us to define whatever view we want inside, otherwise, we should define the exact type to return having in mind the modifiers applied to the view to return.

First, using some View is important for performance: SwiftUI needs to be able to look at the views we are showing and understand how they change, so it can correctly update the user interface. If SwiftUI didn’t have this extra information, it would be really slow for SwiftUI to figure out exactly what changed.

1. How does VStack work – it conforms to the View protocol, but how does it fill the “what kind of content does it have?” hole if it can contain lots of different things inside it?

2. What happens if we send back two views directly from our body property, without wrapping them in a stack?

To answer the first question first, if you create a VStack with two text views inside, SwiftUI silently creates a TupleView to contain those two views – a special type of view that holds exactly two views inside it.

As for the second question, Swift silently applies a special attribute to the body property called @ViewBuilder. This has the effect of silently wrapping multiple views in one of those TupleView containers, so that even though it looks like we’re sending back multiple views they get combined into one TupleView.

## Conditional modifiers

You can use a ternary conditional operator in the properties of a View, for example:

struct ContentView: View {

@State private var useRedText = false

var body: some View {

Button("Hello World") {

// flip the Boolean between true and false

useRedText.toggle()

}

.foregroundColor(**useRedText ? .red : .blue**)

}

}

You can often use regular if conditions to return different views based on some state, but this actually creates more work for SwiftUI – rather than seeing one Button being used with different colors, it now sees two different Button views, and when we flip the Boolean condition it will destroy one to create the other rather than just recolor what it has. So, this kind of code might look the same, but it’s actually less efficient:

var body: some View {

if useRedText {

Button("Hello World") {

useRedText.toggle()

}

.foregroundColor(.red)

} else {

Button("Hello World") {

useRedText.toggle()

}

.foregroundColor(.blue)

}

}

## Environment modifiers

Many modifiers can be applied to containers, which allows us to apply the same modifier to many views at the same time. For example:

VStack {

Text("Gryffindor")

Text("Hufflepuff")

Text("Ravenclaw")

Text("Slytherin")

}

.font(.title)

The font title will be applied to all the Text elements. This is called an environment modifier and is different from a regular modifier that is applied to a view. However, you can use font property in one of the Text views and this last one will have the priority over the container property.

However, not all the modifiers work the same way.

## Views as properties

There are several ways to create complex views:

We could create two text views like this as properties, then use them inside a VStack:

struct ContentView: View {

let motto1 = Text("Draco dormiens")

let motto2 = Text("nunquam titillandus")

var body: some View {

VStack {

motto1

motto2

} }

}

You can even apply modifiers to the properties.

You can create computed properties if you want, like this:

var motto1: some View {

Text("Draco dormiens")

}

This is often a great way to carve up your complex views into smaller chunks, but be careful: unlike the body property, Swift won’t automatically apply the @ViewBuilder attribute here, so if you want to send multiple views back you have three options.

First, you can place them in a stack, like this

var spells: some View {

VStack {

Text("Lumos")

Text("Obliviate")

}

}

If you don’t specifically want to organize them in a stack, you can also send back a Group. When this happens, the arrangement of your views is determined by how you use them elsewhere in your code:

var spells: some View {

Group {

Text("Lumos")

Text("Obliviate")

}

}

The third option is to add the @ViewBuilder attribute yourself,

@ViewBuilder var spells: some View {

Text("Lumos")

Text("Obliviate")

}

## View composition

SwiftUI lets us break complex views down into smaller views without incurring much if any performance impact.

struct CapsuleText: View {

var text: String

var body: some View {

Text(text)

.font(.largeTitle)

.padding()

.foregroundColor(.white)

.background(.blue)

.clipShape(Capsule())

}

}

We can then use that CapsuleText view inside our original view, like this:

struct ContentView: View {

var body: some View {

VStack(spacing: 10) {

CapsuleText(text: "First")

CapsuleText(text: "Second")

} }

}

And you can use more properties to the CapsuleText views inside the body view.

## Custom modifiers

To create a custom modifier, create a new struct that conforms to the **ViewModifier** protocol. This has only one requirement, which is a method called body that accepts whatever content it’s being given to work with, and must return **some View**. For Example:

struct Title: ViewModifier {

func body(content: Content) -> some View {

content

.font(.largeTitle)

.foregroundColor(.white)

.padding()

.background(.blue)

.clipShape(RoundedRectangle(cornerRadius: 10))

}

}

We can now use that with the modifier() modifier – yes, it’s a modifier called “modifier”, but it lets us apply any sort of modifier to a view, like this:

Text("Hello World")

.modifier(Title())

When working with custom modifiers, it’s usually a smart idea to create extensions on View that make them easier to use. For example, we might wrap the Title modifier in an extension such as this:

extension View {

Text("Hello World")

.modifier(Title())

}

We can now use the modifier like this:

Text("Hello World")

.titleStyle()

Custom modifiers can do much more than just apply other existing modifiers – they can also create new view structure, as needed. Remember, modifiers return new objects rather than modifying existing ones, so we could create one that embeds the view in a stack and adds another view:

struct Watermark: ViewModifier {

var text: String

func body(content: Content) -> some View {

ZStack(alignment: .bottomTrailing) {

content

Text(text)

.font(.caption)

.foregroundColor(.white)

.padding(5)

.background(.black)

}

}

}

extension View {

func watermarked(with text: String) -> some View {

modifier(Watermark(text: text))

}

}

With that in place, we can now add a watermark to any view like this:

Color.blue

.frame(width: 300, height: 200)

.watermarked(with: "Hacking with Swift")

## Custom containers

You can create custom containers using a stack called GridStack. What we want to say is that there is a new struct called GridStack that conforms to the View protocol and has a set number of rows and columns, and that inside the grid will be lots of content cells that themselves must conform to the View protocol.

struct GridStack<Content: View>: View {

let rows: Int

let columns: Int

let content: (Int, Int) -> Content

var body: some View {

VStack {

ForEach(0..<rows, id: \.self) { row in

HStack {

ForEach(0..<columns, id: \.self) { column in

content(row, column)

}

}

}

}

}

}

The first line – struct GridStack<Content: View>: View – uses a more advanced feature of Swift called generics, which in this case means “you can provide any kind of content you like, but whatever it is it must conform to the View protocol.” After the colon we repeat View again to say that GridStack itself also conforms to the View protocol.

Take particular note of the let content line – that defines a closure that must be able to accept two integers and return some sort of content we can show.

Tip: When looping over ranges, SwiftUI can use the range directly only if we know for sure the values in the range won’t change over time.

struct ContentView: View {

var body: some View {

GridStack(rows: 4, columns: 4) { row, col in

Text("R\(row) C\(col)")

} }

# Project 04 – Better Rest

All iPhones come with a technology called Core ML built right in, which allows us to write code that makes predictions about new data based on previous data it has seen. We’ll start with some raw data, give that to our Mac as training data, then use the results to build an app able to make accurate estimates about new data – all on device, and with complete privacy for users.

Using a technique called regression analysis we can ask the computer to come up with an algorithm able to represent all our data. This in turn allows it to apply the algorithm to fresh data it hasn’t seen before, and get accurate results.

## Entering numbers with Stepper

A stepper is a control with a – and a + button you can tap to select a specific number. You can use a Stepper with Int, double and more.

In the following example, we create a numeric variable that will be bound to a Stepper and we set some optional parameters to define things like, a range of numbers the user can select, the step to increase or decrease the values and we also show the value in a formatted way, to avoid a lot of zeros after the number.

**struct** ContentView: View {

@State **private** **var** sleepAmount = 8.0

**var** body: **some** View {

Stepper("\(sleepAmount.formatted()) hours",

value: $sleepAmount,

in: 4...12,

step: 0.25)

}

}

## Selecting dates and times with DatePicker

In SwiftUI you can have DatePicker too, for example:

**struct** ContentView: View {

@State **private** **var** wakeUp = Date.now

**var** body: **some** View {

DatePicker("Please enter a date", selection: $wakeUp)

.labelsHidden()

}

}

The labelsHidden is to hide the label in case you need it, which is better than just leaving a blank space in the first parameter.

You can also specify that you only want to see the date part or the hour and minutes like this:

**var** body: **some** View {

DatePicker("Please enter a date", selection: $wakeUp,

displayedComponents: .date)

}

You can work with date ranges, too. For example, you could define a function to have a range of dates from today to tomorrow:

**func** exampleDates() {

// create a second Date instance set to one day in seconds from now

**let** tomorrow = Date.now.addingTimeInterval(86400)

// create a range from those two

**let** range = Date.now...tomorrow

}

You can define a date range from today on, so the user cannot select past dates:

**var** body: **some** View {

DatePicker("Please enter a date", selection: $wakeUp,

in: Date.now...

)

}

## Working with Dates

When working with dates, you must try to use the Apple’s framework to do calculations, instead of doing your own calculations, like for example:

let now = Date.now

let tomorrow = Date.now.addingTimeInterval(86400)

let range = now...tomorrow

In the previous example, we are getting now and tomorrow by adding 86400 seconds, which is what you have in 24 hours, but you must try to avoid using this kind of calculous.

There are some challenges when working with dates like:

1. Choosing a sensible default “wake up” time.

2. Reading the hour and minute they want to wake up.

3. Showing their suggested bedtime neatly formatted.

For first challenge, we can use DateComponents, a special type that allows you read or write different parts of the date instead the whole thing:

var components = DateComponents()

components.hour = 8

components.minute = 0

let date = Calendar.current.date(from: components) ?? Date.now

In the previous example, we say, we want a date with 8 hours and 0 minutes, and if getting that date fails, give me the current date.

For the second challenge, to get a date or hours from a DatePicker or the current date, we can use DateComponents too:

let components =

Calendar.current.dateComponents([.hour, .minute], from:

someDate)

let hour = components.hour ?? 0

let minute = components.minute ?? 0

someDate can be a DatePicker or Date.now, for example.

For the third challenge, for example, if we just wanted the time from a date, we would write this:

Text(Date.now, format: .dateTime.hour().minute())

When we write day().month().year() we’re asking for that data, not arranging it, and iOS will automatically format that data using the user’s preferences.

As an alternative, we can use the formatted() method directly on dates, passing in configuration options for how we want both the date and the time to be formatted, like this:

Text(Date.now.formatted(date: .long, time: .shortened))

## Training a model with Create ML

iOS 11 came with a Machine Learning framework called Core ML, a second framework was introduced 1 year later called Create ML.

Core ML is capable of handling a variety of training tasks, such as recognizing images, sounds, and even motion, but in this instance we’re going to look at tabular regression.

Machine learning is done in two steps: we train the model, then we ask the model to make predictions. Training is the process of the computer looking at all our data to figure out the relationship between all the values we have, and in large data sets it can take a long time – easily hours, potentially much longer. Prediction is done on device: we feed it the trained model, and it will use previous results to make estimates about new data.

To start training the model, open Create ML by going to the Xcode menu and choosing Open Developer Tool > Create ML. The first thing Create ML app will do is ask you to create a project or open a previous one.

With a sample file called BetterRest.csv, where we have 4 columns (wake, estimatedSleep, coffee and actualSleep), we select this file (to load it) in the Training Data box, for the target we define the actualSleep, which is the value we want to predict and to do this, we will use select the other 3 columns.

A screenshot of a computer

Description automatically generated

In the Algorithm field, there are several options, but for this example, we will use Automatic and click on the Train button.

Once the training has finished, you can go to the Evaluation tab and click on the Validation tab to see some result metrics. The value Root Mean Square Error means on average the model was able to predict suggested accurate sleep time with an error of only 170 seconds, or three minutes.

Even better, if you go to the Output tab you’ll see an our finished model has a file size of 544 bytes or so. Create ML has taken 180KB of data, and condensed it down to just 544 bytes – almost nothing.

To export the trained model, go to the Output tab and click on Get button to save the model and use it on Xcode.

## Building a basic layout

**struct** ContentView: View {

@State **private** **var** wakeUp = Date.now

@State **private** **var** sleepAmount = 8.0

@State **private** **var** coffeeAmount = 1

**var** body: **some** View {

NavigationView{

VStack {

Text("When do you want to wake up?")

.font(.headline)

DatePicker("Please enter a time", selection: $wakeUp,

displayedComponents: .hourAndMinute)

.labelsHidden()

Text("Desired amount of sleep")

.font(.headline)

Stepper("\(sleepAmount.formatted()) hours", value: $sleepAmount, in: 4...12,

step: 0.25)

Text("Daily coffee intake")

.font(.headline)

Stepper(coffeeAmount == 1 ? "1 cup" : "\(coffeeAmount) cups", value:

$coffeeAmount, in: 1...20)

}

.navigationTitle("BetterRest")

.toolbar{

Button("Calculate", action: calculateBedtime)

}

}

}

**func** calculateBedtime(){

}

}

## Connecting SwiftUI to Core ML

To use the model you have created and trained, first you need to add it to the project. To do this, just drag and drop the mlmodel file in the project navigation bar, where the other files are:

A screenshot of a computer

Description automatically generated

Make sure you select “Copy files if needed” and finish.

Xcode will create a class (that you don’t see in the project) with the same name as the file.

In the example, the model receives 3 arguments, all of them are double values.

So the function calculateBedtime will make an instance of the MLModelConfiguration to pass it to the instance of SleepCalculator (the model we have created and we have renamed to this).

We will get the wake up time, which is in the sum of hours and minutes taken from the wakeup calendar. To get this values, we use the Calendar.current.dateComponents and convert them to seconds multiplying by 60.

To get the prediction, we use the object model.prediction and pass the values we have. The prediction will have the actualSleep time in seconds. We use this time to calculate the time the user should go to bed, by subtracting this value from the wakeUp value. Then we give it a format and display the value in an alert.

**func** calculateBedtime(){

**do**{

**let** config = MLModelConfiguration()

**let** model = **try** SleepCalculator(configuration: config)

// Get the hour and minutes from the wake up time selected by the user

**let** components = Calendar.current.dateComponents([.hour, .minute], from: wakeUp)

// Get the hour and minutes in seconds

**let** hour = (components.hour ?? 0) \* 60 \* 60

**let** minute = (components.minute ?? 0) \* 60

// Feed the values to the CoreML module

**let** prediction = **try** model.prediction(wake: Double(hour + minute),

estimatedSleep: sleepAmount, coffee: Double(coffeeAmount))

// Get the time the user needs to go to sleep by substracting the actualSleep from the wakeup value

// The actualSleep is in seconds

**let** sleepTime = wakeUp - prediction.actualSleep

alertTitle = "Your ideal bedtime is..."

alertMessage = sleepTime.formatted(date: .omitted, time: .shortened)

} **catch** {

alertTitle = "Error"

alertMessage = "Sorry, there was a problem calculating your bedtime"

}

showAlert = **true**

}

## Cleaning up the UI

In the example, we add a computed property to the ContentView struct, that contains a Date value referencing 7am of the current day:

**static** **var** defaultWakeTime: Date {

**var** components = DateComponents()

components.hour = 7

components.minute = 0

**return** Calendar.current.date(from: components) ?? Date.now

}

So, the wakeUp property, now looks like this:

@State **private** **var** wakeUp = defaultWakeTime

The defaultWakeTime property is static to avoid accessing one property from inside another one. In other words, it belongs to the ContentView struct itself instead a single instance of that struct.

For the style, we can use a Form instead the VStack and separate every title and data field into a VStack:

**var** body: **some** View {

NavigationView{

Form {

VStack(alignment: .leading, spacing: 0) {

Text("When do you want to wake up?")

.font(.headline)

DatePicker("Please enter a time", selection: $wakeUp,

displayedComponents: .hourAndMinute)

.labelsHidden()

}

VStack(alignment: .leading, spacing: 0) {

Text("Desired amount of sleep")

.font(.headline)

Stepper("\(sleepAmount.formatted()) hours", value: $sleepAmount, in: 4...12,

step: 0.25)

}

VStack(alignment: .leading, spacing: 0) {

Text("Daily coffee intake")

.font(.headline)

Stepper(coffeeAmount == 1 ? "1 cup" : "\(coffeeAmount) cups", value:

$coffeeAmount, in: 1...20)

}

}

.navigationTitle("BetterRest")

.toolbar{

Button("Calculate", action: calculateBedtime)

}

.alert(alertTitle, isPresented: $showAlert){

Button("OK") { }

} message: {

Text(alertMessage)

}

}

}

# Project 05 – Word Scramble

The next project will show players a random eight-letter word and ask them to make words out of it. Along the way you’ll meet List, onAppear(), Bundle, fatalError(), and more – all useful skills that you’ll use for years to come. You’ll also get some practice with @State, NavigationView, and more.

## Introduction to List

The job of **List** is to provide a scrolling table of data. Just like Form, you can provide List a selection of static and dynamic views:

List {

Section("Section 1") {

Text("Static row 1")

Text("Static row 2")

}

Section("Section 2") {

ForEach(0..<5) {

Text("Dynamic row \($0)")

}

}

Section("Section 3") {

Text("Static row 3")

Text("Static row 4")

}

}

You’ll notice that this list looks similar to the form we had previously, but we can adjust how the list looks using the **listStyle()** modifier, like this:

.listStyle(.grouped)

One thing List can do that Form can’t is to generate its rows entirely from dynamic content without needing a ForEach. Example:

List(0..<5) {

Text("Dynamic row \($0)")

}

Lists work well with arrays because SwiftUI can identify each row uniquely based on its position in the range. When working with an array of data, SwiftUI still needs to know how to identify each row uniquely, so if one gets removed it can simply remove that one rather than having to redraw the whole list. This is where the id parameter comes in, and it works identically in both List and ForEach – it lets us tell SwiftUI exactly what makes each item in the array unique.

When working with arrays of strings and numbers, the only thing that makes those values unique is the values themselves. When working with this kind of list data, we use id: \.self like this:

**struct** ContentView: View {

**let** people = ["Finn", "Leia", "Luke", "Rey"]

**var** body: **some** View {

List(people, id: \.**self**) {

Text($0) }

}

}

## Loading resources from your app bundle

When Xcode builds your iOS app, it creates something called a “bundle”. It allows the system to store all the files for a single app in one place – the binary code.

When you want to look in a bundle for a file you placed there, you can use a new data type called URL. If we want to read the URL for a file in our main app bundle, we use Bundle.main.url(). If the file exists, it will be sent back, otherwise, we’ll get nil.

What’s inside the URL doesn’t really matter, because iOS uses paths that are impossible to guess – our app lives in its own sandbox, and we shouldn’t try to read outside of it.

**func** loadFile(){

**if** **let** fileURL = Bundle.main.url(forResource: "some-file", withExtension: "txt"){

**if** **let** fileContents = **try**? String(contentsOf: fileURL){

//fileContents is a String

}

}

}

Once we have a URL, we can load it into a string with a special initializer: **String(contentsOf:)**. We give this a file URL, and it will send back a string containing the contents of that file if it can be loaded. If it *can’t* be loaded it throws an error, so you you need to call this using **try** or **try?**

## Working with Strings

Swift gives us a method called **components(separatedBy:)** that can converts a single string into an array of strings by breaking it up wherever another string is found. For example, this will create the array **["a", "b", "c"]**:

let input = "a b c"

let letters = input.components(separatedBy: " ")

Once you have created the array with the components function, you can get a random element from it by using randomElement():

let letter = letters.randomElement()

This method returns an optional string, so you must either unwrap or use it with nil coalescing.

Another useful string method is **trimmingCharacters(in:)**, which asks Swift to remove certain kinds of characters from the start and end of a string. This uses a new type called **CharacterSet**, but most of the time we want one particular behavior: removing whitespace and new lines – this refers to spaces, tabs, and line breaks, all at once.

let trimmed =

letter?.trimmingCharacters(in: .whitespacesAndNewlines)

Another string functionality we can use is the spell checker, provided by the class UITextChecker. The class comes from UIKit and it is written in Objective-C.

**func** testCheckSpell(){

// 1. You must crete a word to check and an instance of UITextChecker

**let** word = "swift"

**let** checker = UITextChecker()

// 2. Tell the checker ow much of our string we want to check

**let** range = NSRange(location: 0, length: word.utf16.count)

// 3. Ask our text checker to report where it found any misspellings in our word

**let** misspelledRange = checker.rangeOfMisspelledWord(in: word, range: range, startingAt: 0, wrap: **false**, language: "en")

// 4. Check that there are no spelling mistake

**let** allGood = misspelledRange.location == NSNotFound

}

## Adding to a list of Words

In the following code, we have a method called addNewWord that will:

1. Lowercase newWord and remove any whitespace
2. Check that it has at least 1 character, otherwise exit.
3. Insert that word at position 0 in the usedWords array.
4. Set newWord back to be an empty string

**struct** ContentView: View {

@State **private** **var** usedWords = [String]()

@State **private** **var** rootWord = ""

@State **private** **var** newWord = ""

**var** body: **some** View {

List {

Section {

TextField("Enter your word", text: $newWord)

// Do not allow capitalization for the word

.autocapitalization(.none)

}

Section{

ForEach(usedWords, id: \.**self**) { word **in**

HStack{

// This line allows you to show the count of letters of the word in a circle

Image(systemName: "\(word.count).circle")

Text(word)

}

}

}

}

.navigationTitle(rootWord)

// This modifier adds an action to perform when the user submits a value to this view.

.onSubmit(addNewWord)

}

**func** addNewWord(){

// Lowercase and trim the word, to make sure we don't add duplicate words with case differences

**let** answer = newWord.lowercased().trimmingCharacters(in: .whitespacesAndNewlines)

// exit if the remaining string is empty

**guard** answer.count > 0 **else** { **return** }

// Extra validation

withAnimation{

usedWords.insert(answer, at: 0)

}

newWord = ""

}

}

A couple of notes about the previous code:

* The modifier autocapitalization can be used when you need to autocapitalice a sentence or word, or avoid it by using the .none value.
* The .onSubmit adds an action to perform when the user submits a value. In the example is added to the List, but it can be added to the TextField or in any other element in the screen.
* The withAnimation block allows you to add an animation to the action of inserting the new word to the usedWord which eventually, will update the list.

## Running code when our app launches

For this project, once you have downloaded the start.txt file, drag it to the project pane, and use the following options:

A screenshot of a computer

Description automatically generated

In the following function, we define the behavior for the start of the game:

**func** startGame(){

**if** **let** startWordsURL = Bundle.main.url(forResource: "start", withExtension: "txt"){

// Load start text into a string

**if** **let** startWords = **try**? String(contentsOf: startWordsURL){

// Get all words by spliting starWords

**let** allWords = startWords.components(separatedBy: "\n")

// Get a random word from the array

rootWord = allWords.randomElement() ?? "silkworm"

**return**

}

}

// If the start file was not found or cannot be loaded, a fatal error should

// have happened

fatalError("Could not load start.txt from bundle")

}

In the previous function:

* We find the start.txt with the Bundle.main.url method.
* Load the file into a string.
* Split that string into array of strings, where each element is a word.
* Pick one random word to the assigned as rootWord or use a default word if array is empty.

In the last part of the function, if the file was not found or there was an error loading it, we show a fatalError which will crash the app.

To call this function from the start, we make use of the onAppear function as a modifier for the List, to start the game:

.onAppear(perform: startGame)

## Validating words with UITextChecker

In the project, we will include 4 more functions:

* isOriginal will validate the word has not been used
* isPossible, will validate the word sent is possible to use based on the letter from the rootWord.
* isReal, will validate that the word exists or is not misspelled using UITextChecker. If there are no misspells in the word, it exists.
* A function to show the alert with the error title and error message.

Finally, we use these function from the addNewWord function.

This is the full code:

@State **private** **var** usedWords = [String]()

@State **private** **var** rootWord = ""

@State **private** **var** newWord = ""

@State **private** **var** errorTitle = ""

@State **private** **var** errorMessage = ""

@State **private** **var** showingError = **false**

**var** body: **some** View {

NavigationStack{

List {

Section {

TextField("Enter your word", text: $newWord)

// Do not allow capitalization for the word

.autocapitalization(.none)

}

Section{

ForEach(usedWords, id: \.**self**) { word **in**

HStack{

// This line allows you to show the count of letters of the word in a circle

Image(systemName: "\(word.count).circle")

Text(word)

}

}

}

}

.navigationTitle(rootWord)

// This modifier adds an action to perform when the user submits a value to this view.

.onSubmit(addNewWord)

// This modifier performs a function before the view appears

.onAppear(perform: startGame)

.alert(errorTitle, isPresented: $showingError){

Button("OK", role: .cancel) {}

} message: {

Text(errorMessage)

}

}

}

**func** addNewWord(){

// Lowercase and trim the word, to make sure we don't add duplicate words with case differences

**let** answer = newWord.lowercased().trimmingCharacters(in: .whitespacesAndNewlines)

// exit if the remaining string is empty

**guard** answer.count > 0 **else** { **return** }

**guard** isOriginal(word: answer) **else** {

wordError(title: "Word used already", message: "Be more original")

**return**

}

**guard** isPossible(word: answer) **else** {

wordError(title: "Word not possible", message: "You can't spell that word from '\(rootWord)'!")

**return**

}

**guard** isReal(word: answer) **else** {

wordError(title: "Word not recognized", message: "You can't just make them up, you know!")

**return**

}

withAnimation{

usedWords.insert(answer, at: 0)

}

newWord = ""

}

**func** startGame(){

**if** **let** startWordsURL = Bundle.main.url(forResource: "start", withExtension: "txt"){

// Load start text into a string

**if** **let** startWords = **try**? String(contentsOf: startWordsURL){

// Get all words by spliting starWords

**let** allWords = startWords.components(separatedBy: "\n")

// Get a random word from the array

rootWord = allWords.randomElement() ?? "silkworm"

**return**

}

}

// If the start file was not found or cannot be loaded, a fatal error should

// have happened

fatalError("Could not load start.txt from bundle")

}

// This function validates if the word has been already used

**func** isOriginal(word: String) -> Bool{

!usedWords.contains(word)

}

// This function validates if the word passed uses all letter available in the rootWord

**func** isPossible(word: String) -> Bool {

**var** tempWord = rootWord

**for** letter **in** word {

**if** **let** pos = tempWord.firstIndex(of: letter){

tempWord.remove(at: pos)

} **else** {

**return** **false**

}

}

// Every letter in the word was found

**return** **true**

}

// This function will validates if the word entered is real

**func** isReal(word: String) -> Bool {

**let** checker = UITextChecker()

**let** range = NSRange(location: 0, length: word.utf16.count)

**let** misspelledRange = checker.rangeOfMisspelledWord(in: word, range: range, startingAt: 0, wrap: **false**, language: "en")

// If the word is not misspelled, then is a real word

**return** misspelledRange.location == NSNotFound

}

// This will show the alert with the error message passed as parameters

**func** wordError(title: String, message: String){

errorTitle = title

errorMessage = message

showingError = **true**

}

}

# Project 06 - Animation

## Implicit Animations

An implicit animation is the simplest type in SwiftUI, you tell the view, if someone wants to animate you, here’s how you should respond. In the following example, we define a rounded button, and we will use the scaleEffect along with a state property to increase the size of the button. The value in this scaleEffect goes from 0 to 1.0 which represents the 100% of the normal size of the button.

To make this size increasing process to be animated, we use animation modifier. The implicit animation takes effect on all properties of the view that change, so by adding another animation modifier, like the blur, you will see how the button scales and blurs smoothly.

**struct** ContentView: View {

@State **private** **var** animationAmount = 1.0

**var** body: **some** View {

Button("Tap me"){

animationAmount += 1

}

.padding(50)

.background(.red)

.foregroundColor(.white)

.clipShape(Circle())

.scaleEffect(animationAmount)

.blur(radius: (animationAmount - 1) \* 3)

.animation(.default, value: animationAmount)

}

}

## Customizing Animations

We can control the type of animation used by passing in different values to the modifier. For example, we could use **.easeOut** to make the animation start fast then slow down to a smooth stop:

.animation(.easeOut, value: animationAmount)

Remember that implicit animations always need to watch a particular value, otherwise they will be triggered for every small change, even rotating the device.

There are even spring animations, that cause the movement to overshoot then return to settle at its target. You can control the initial stiffness of the spring (which sets its initial velocity when the animation starts), and also how fast the animation should be “damped”

.animation(.interpolatingSpring(stiffness: 50, damping: 1),

value: animationAmount)

You can also specify the number of seconds for the animation’s duration:

.animation(.easeInOut(duration: 2), value: animationAmount)

You can also use the modifier .delay to set a specific time before the animation starts.

For continuous animations, there is a **repeatForever()** modifier that can be used like this

.animation(

.easeInOut(duration: 1)

.repeatForever(autoreverses: true),

value: animationAmount

)

We can use these **repeatForever()** animations in combination with **onAppear()** to make animations that start immediately and continue animating for the life of the view.

struct ContentView: View {

@State private var animationAmount = 1.0

var body: some View {

Button("Tap me"){

//animationAmount += 1

}

.padding(50)

.background(.red)

.foregroundColor(.white)

.clipShape(Circle())

.overlay(

Circle()

.stroke(.red)

.scaleEffect(animationAmount)

.opacity(2 - animationAmount)

.animation(

.easeInOut(duration: 1)

.repeatForever(autoreverses: false),

value: animationAmount

)

)

.onAppear{

animationAmount = 2

}

}

}

That makes a stroked red circle over our button, using an opacity value of **2 - animationAmount** so that when **animationAmount** is 1 the opacity is 1 (it’s opaque) and when **animationAmount** is 2 the opacity is 0 (it’s transparent).

## Animation Bindings

The **animation()** modifier can be applied to any SwiftUI binding, which causes the value to animate between its current and new value. This also applies to Boolean data. For example:

**struct** ContentView: View {

@State **private** **var** animationAmount = 1.0

**var** body: **some** View {

VStack {

Stepper("Scale amount", value: $animationAmount.animation(), in: 1...10)

Spacer()

Button("Tap me"){

animationAmount += 1

}

.padding(50)

.background(.red)

.foregroundColor(.white)

.clipShape(Circle())

.scaleEffect(animationAmount)

}

}

}

As you can see, the stepper can move **animationAmount** up and down, and tapping the button will add 1 to it – they are both tied to the same data, which in turn causes the size of the button to change. However, tapping the button changes **animationCount** immediately, so the button will just jump up to its larger size. In contrast, the stepper is bound to **$animationAmount.animation()**, which means SwiftUI will automatically animate its changes.

SwiftUI is examining the state of our view before the binding changes, examining the target state of our views *after* the binding changes, then applying an animation to get from point A to point B.

This is why we can animate a Boolean changing: Swift isn’t somehow inventing new values between false and true, but just animating the view changes that occur as a result of the change.

These binding animations use a similar **animation()** modifier that we use on views, so you can go to town with animation modifiers if you want to:

Stepper("Scale amount", value: $animationAmount.animation(

.easeInOut(duration: 1)

), in: 1...10)

**Tip:** With this variant of the **animation()** modifier, we don’t need to specify which value we’re watching for changes – it’s literally attached to the value it should watch!

## Creating explicit animations

You can also use 3D animation with some modifiers SwiftUI offers, like rotation3DEffct():

* If we skewer the view through the X axis (horizontally) then it will be able to spin forwards and backwards.
* If we skewer the view through the Y axis (vertically) then it will be able to spin left and right.
* If we skewer the view through the Z axis (depth) then it will be able to rotate left and right.

**struct** ContentView: View {

@State **private** **var** animationAmount = 0.0

**var** body: **some** View {

Button("Tap Me") {

withAnimation(.interpolatingSpring(stiffness: 5, damping: 1)){

animationAmount += 360

}

}

.padding(50)

.background(.red)

.foregroundColor(.white)

.clipShape(Circle())

.rotation3DEffect(.degrees(animationAmount), axis: (x: 0, y: 1,

z: 0))

}

}

Along with the rotation3DEffect modifier, we need to use withAnimation at the moment of changing the value for the animationAmount, if not, the change will happen immediately.

The interpolatingSpring add another effect to use a spring animation.

## Controlling the animation stack

It is important to remember that the order of modifiers matters, and it also applies to animation modifiers.

Besides that, you can have as many animation modifiers as you want, and the order of these modifiers will matter.

Now for the fun part: if we apply multiple **animation()** modifiers, each one controls everything before it up to the next animation. This allows us to animate state changes in all sorts of different ways rather than uniformly for all properties.

**struct** ContentView: View {

@State **private** **var** enabled = **false**

**var** body: **some** View {

Button("Tap Me") {

enabled.toggle()

}

.frame(width: 200, height: 200)

.background(enabled ? .blue : .red)

.animation(.default, value: enabled)

.foregroundColor(.white)

.clipShape(RoundedRectangle(cornerRadius: enabled ? 60 : 0))

.animation(.interpolatingSpring(stiffness: 10, damping: 1), value: enabled)

}

}

For even more control, it’s possible to disable animations entirely by passing **nil** to the modifier.

Button("Tap Me") {

enabled.toggle()

}

.frame(width: 200, height: 200)

.background(enabled ? .blue : .red)

.animation(nil, value: enabled)

.foregroundColor(.white)

.clipShape(RoundedRectangle(cornerRadius: enabled ? 60 : 0))

.animation(.interpolatingSpring(stiffness: 10, damping: 1),

value: enabled)

## Animating gestures

SwiftUI allows you to add and animate gestures, like the drag gesture in the following example:

**struct** ContentView: View {

@State **private** **var** dragAmount = CGSize.zero

**var** body: **some** View {

LinearGradient(gradient: Gradient(colors: [.yellow, .red]), startPoint: .topLeading, endPoint: .bottomTrailing)

.frame(width: 300, height: 200)

.clipShape(RoundedRectangle(cornerRadius: 10))

.offset(dragAmount)

.gesture(

DragGesture()

.onChanged { dragAmount = $0.translation }

.onEnded { \_ **in** dragAmount = .zero }

)

.animation(.spring(), value: dragAmount)

}

}

In the previous example, besides adding the drag gesture to the “card”, the object is animated with a spring animation.

You can also animate just the onEnded method:

LinearGradient(gradient: Gradient(colors: [.yellow, .red]), startPoint: .topLeading, endPoint: .bottomTrailing)

.frame(width: 300, height: 200)

.clipShape(RoundedRectangle(cornerRadius: 10))

.offset(dragAmount)

.gesture(

DragGesture()

.onChanged { dragAmount = $0.translation }

**.onEnded { \_ in**

**withAnimation{**

**dragAmount = .zero**

**}**

**}**

)

You can also add a delay to the animations:

struct ContentView: View {

let letters = Array("Hello, SwiftUI")

@State private var enabled = false

@State private var dragAmount = CGSize.zero

var body: some View {

HStack(spacing: 0){

ForEach(0..<letters.count) { num in

Text(String(letters[num]))

.padding(5)

.font(.title)

.background(enabled ? .blue : .red)

.offset(dragAmount)

.animation(

**.default.delay(Double(num) / 20),**

value: dragAmount)

}

}

.gesture(

DragGesture()

.onChanged{ dragAmount = $0.translation }

.onEnded{ \_ in

dragAmount = .zero

enabled.toggle()}

)

}

}

## Showing and hiding Views with transitions

You can animate when a view is hiding or showing by using the withAnimation modifier along with the transition modifier. This transition allows simple like .scale or asymmetric transitions when you define the type of transition when it is inserting the element and when it is removing it:

**struct** ContentView: View {

@State **private** **var** isShowingRed = **false**

**var** body: **some** View {

VStack{

Button("Tap Me") {

withAnimation{

isShowingRed.toggle()

}

}

**if** isShowingRed {

Rectangle()

.fill(.red)

.frame(width: 200, height: 200)

.transition(.asymmetric(insertion: .scale, removal: .opacity))

}

}

}

}

## Building custom transitions using ViewModifier

SwiftUI allows you to create new transitions by adding or removing views using custom animations. This can be made by using the .modifier transition, which accepts any view modifier we want, but we need to instantiate the modifier, in other words, we need to create it.

So, in the following example, we will be using a custom modifier, by creating a CornerRotateModifier struct that has an anchor point to control where the rotation should take place, and an amount to control how much rotation should be applied.

The .clipped means that when the view rotates the parts that are lying outside the natural rectangle won’t get drawn.

The use of the CornerRotateModifier is made using an extension to AnyTransition, and making it to rotate from -90 to 0 on its top leading corner.

The pivot animation is attached to any view using the .transition modifier.

**struct** CornerRotateModifier: ViewModifier {

**let** amount: Double

**let** anchor: UnitPoint

**func** body(content: Content) -> **some** View {

content

.rotationEffect(.degrees(amount), anchor: anchor)

.clipped()

}

}

**extension** AnyTransition {

**static** **var** pivot: AnyTransition{

.modifier(active: CornerRotateModifier(amount: -90, anchor: .topLeading),

identity: CornerRotateModifier(amount: 0, anchor: .topLeading))

}

}

**struct** ContentView: View {

@State **private** **var** isShowingRed = **false**

**var** body: **some** View {

ZStack{

Rectangle()

.fill(.blue)

.frame(width: 200, height: 200)

**if** isShowingRed {

Rectangle()

.fill(.red )

.frame(width: 200, height: 200)

.transition(.pivot)

}

}

.onTapGesture {

withAnimation{

isShowingRed.toggle()

}

}

}

}

# Project 07 – iExpense

## Introduction

SwiftUI’s **State** property wrapper is designed for simple data that is local to the current view, but as soon as you want to share data between views it stops being useful.

For example:

struct ContentView: View {

@State private var user = User()

var body: some View {

VStack {

Text("Your name is \(user.firstName) \(user.lastName).")

TextField("First name", text: $user.firstName)

TextField("Last name", text: $user.lastName)

}

} }

With a struct, when a value changes, the whole struct changes.

For SwiftUI developers, what this means is that if we want to share data between multiple views – if we want two or more views to point to the same data so that when one changes they all get those changes – we need to use classes rather than structs.

So, instead of having a struct, we use class:

**class** User {

**var** firstName = "Bilbo"

**var** lastName = "Baggins"

}

When we use **@State**, we’re asking SwiftUI to watch a property for changes. So, if we change a property’s value, SwiftUI will re-invoke the body property of the view. Basically, a change in a property creates a new instance of the struct. @State was able to spot that change, and automatically reloaded our view. Now that we have a class, that behavior no longer happens: Swift can just modify the value directly.

For structs we need the mutating keyword for struct methods that modify properties, because the struct itself is constant. Swift needs to be able to destroy and recreate the whole struct when a property changes, and that is not possible for constant structs. Classes don’t need the mutating keyword, because even if the class instance is marked as constant Swift can still modify variable properties.

## Sharing SwiftUI state with @StateObject

To share data in SwiftUi, you have 3 property wrappers to help you with this: @StateObject, @ObervedObject and @EnvironmentObject.

The @State is designed to track local structs rather than classes. When using classes, you need to tell SwiftUI what views should be reloaded when they change, by using property wrappers. In the following example we have our class User1 with 2 properties. Whenever they change, we want to notify any view watching our class that a change has happened. We can do this by using @Published property observer.

Then, the @StateObject property wrapper tells SwiftUI that we’re creating a new class instance that should be watched for any change announcement.

**class** User1 : ObservableObject {

**@Published** **var** firstName = "Bilbo"

**@Published** **var** lastName = "Baggins"

}

**struct** StateObjectExample: View {

**@StateObject** **var** user = User1()

**var** body: **some** View {

VStack {

Text("Your name is \(user.firstName) \(user.lastName)")

TextField("First Name", text: $user.firstName)

TextField("Last Name", text: $user.lastName)

}

}

}

To use the @StateObject we need to conform the ObservableObjet protocol in the class.

As you’ve seen, rather than just using @State to declare local state, we now take three steps:

* Make a class that conforms to the ObservableObject protocol.
* Mark some properties with @Published so that any views using the class get updated when they change.
* Create an instance of our class using the @StateObject property wrapper.

The end result is that we can have our state stored in an external object, and, even better, we can now use that object in multiple views and have them all point to the same values.

However, there is something important: @StateObject tells SwiftUI that we’re creating a new class instance that should be watched for any change announcements, but that should only be used when you’re *creating* the object like we are with our **User1** instance.

When you want to use a class instance elsewhere – when you’ve created it in view A using **@StateObject** and want to use that same object in view B – you use a slightly different property wrapper called **@ObservedObject**.

## Showing and hiding views

One of the ways to show views in SwiftUI is using a sheet: a new view presented on top of our existing one. Sheets work like alerts, but we define the conditions under which sheet should be shown and when those conditions become true or false.

**import** SwiftUI

**struct** SecondView: View {

@Environment(\.dismiss) **var** dismiss

**let** name: String

**var** body: **some** View {

VStack {

Text("Hello, \(name)!")

Button("Dismiss") {

dismiss()

}

}

}

}

**struct** FirstView: View {

@State **private** **var** showingSheet = **false**

**var** body: **some** View {

Button("Show Sheet") {

showingSheet.toggle()

}

.sheet(isPresented: $showingSheet){

SecondView(name: "Esteban")

}

}

}

#Preview {

FirstView()

}

First thing to note is to have a state to track whether the sheet is showing or not (showingSheet var).

Then, we toggle its value with the button.

Third, we need to attach our sheet somewhere to our view hierarchy. We do it with the .sheet(isPresented…) modifier.

We then define the second view. In this view, we can pass parameters and make the view dismiss itself. To dismiss another view, we need another property wrapper: @Environment. It allows us to create properties that store values provided to us externally.

We need to ask the environment to dismiss our view, because it might have been presented in any number of different ways. So, we’re effectively saying “hey, figure out how my view was presented, then dismiss it appropriately.”

To try it out add this property to **SecondView**, which creates a property called **dismiss** based on a value from the environment.

## Deleting items using onDelete()

In SwiftUI we can use the onDelete() to remove objects from a collection. Mostly exclusive for List and ForEach, but there is another place we can use it.

**struct** OnDeleteExample: View {

@State **private** **var** numbers = [Int]()

@State **private** **var** currentNumber = 1

**var** body: **some** View {

NavigationView {

VStack {

List {

ForEach(numbers, id: \.**self**) {

Text("Row \($0)")

}

.onDelete(perform: removeRows)

}

Button("Add Number") {

numbers.append(currentNumber)

currentNumber += 1

}

}

.navigationTitle("onDelete()")

.toolbar {

EditButton()

}

}

}

**func** removeRows(at offsets: IndexSet){

numbers.remove(atOffsets: offsets)

}

}

In the previous example, we have a view where we can add items to a list and they are displayed using a ForEach, which is the one that has the onDelete method attached. We can add the items to the list without using the ForEach, but the onDelete modifier only exists on ForEach.

In order to make **onDelete()** work, we need to implement a method that will receive a single parameter of type **IndexSet**. This is a bit like a set of integers, except it’s sorted, and it’s just telling us the positions of all the items in the **ForEach** that should be removed. This method is the removeRows.

And finally, we tell SwiftUI to call this method when it wants to delete data from ForEach.

In the example, we also added a NavigationView to add the modifier .toolbart to the VStack and be able to use an Edit button that will show the option to delete the items from the list and not only by swiping the item from right to left.

## Storing user settings with UserDefaults

One common way to store small amount of data is called UserDefaults. The recommendation is not to store more than 512KB in there.

**UserDefaults** is perfect for storing things like when the user last launched the app, which news story they last read, or other passively collected information.

In the following code, we use UserDefaults.standard to set and get the value stored, using a string for a key name.

**struct** StoringUserSettings: View {

@State **private** **var** tapCount = **UserDefaults.standard.integer(forKey: "Tap")**

**var** body: **some** View {

Button("Tap count: \(tapCount)"){

tapCount += 1

**UserDefaults.standard.setValue(tapCount, forKey: "Tap")**

}

}

}

So, the value will be kept after the user closes the app and launches it again. But it is important to note that it is important to have a default value. Second, it takes iOS a little time to write your data to permanent storage – to actually save that change to the device. They don’t write updates immediately because you might make several back to back, so instead they wait some time then write out all the changes at once. How much time is another number we don’t know, but a couple of seconds ought to do it.

SwiftUI provides an @AppStorage property wrapper around UserDefaults, and in simple situations like this one it’s really helpful:

**struct** StoringUserSettings: View {

@AppStorage("tapCount") **private** **var** tapCount = 0

**var** body: **some** View {

Button("Tap count: \(tapCount)"){

tapCount += 1

}

}

}

There are three important things to note:

1. Our access to the **UserDefaults** system is through the **@AppStorage** property wrapper. This works like **@State**: when the value changes, it will reinvoked the **body** property so our UI reflects the new data.

2. We attach a string name, which is the **UserDefaults** key where we want to store the data. I’ve used “tapCount”, but it can be anything at all – it doesn’t need to match the property name.

3. The rest of the property is declared as normal, including providing a default value of 0. That will be used if there is existing value saved inside **UserDefaults**.

## Archiving Swift objects with Codable

When you need to store custom Swift types, you need to use something else than the @AppStorage.

For example:

**struct** UserObj: **Codable** {

**let** firstName: String

**let** lastName: String

}

**struct** CodableExample: View {

@State **private** **var** user = UserObj(firstName: "John", lastName: "Smith")

**var** body: **some** View {

Button("Save User"){

**let** encoder = JSONEncoder()

**if** **let** data = **try**? encoder.encode(user){

UserDefaults.standard.setValue(data, forKey: "UserData")

}

}

}

}

In the previous example, we defined a UserObj to store. In order to do this, we use the Codable protocol when defining the struct, which allows you to convert objects into plain text and back again.

Swift will automatically generate some code for us that will archive and unarchive **User** instances for us as needed, but we still need to tell Swift *when* to archive and what to do with the data.

This part of the process is powered by a new type called **JSONEncoder**. Its job is to take something that conforms to **Codable** and send back that object in JSON format. The Codable protocol doesn’t require that we use JSON, and in fact other formats are available, but it is by far the most common.

To convert the user data we use the encode() method of JSONEncoder, this might throw errors, so it should be called with try or try? To handle errors. That accesses UserDefaults directly rather than going through @AppStorage

## The project

First, we need to define a struct that will be used to handle the expense items.

The first one is the ExpenseItem that will represent every item in the list. This will be using a UUID (Universally Unique Identifier) to identify every item. The struct will conform the protocol called Identifiable, which only requirement is to have a property of type UUID. With this, we are telling SwiftUI that this type can be identified uniquely, this will help us when we need to delete the item from the list:

**struct** ExpenseItem: Identifiable, Codable {

// Generate a UUID automatically for every item

**let** id = UUID()

**let** name: String

**let** type: String

**let** amount: Double

}

The previous struct also conforms Codable, so we can encode and decode the item in order to save it to the user defaults.

Then, we define a class called Expenses that will conform the ObservableObject:

**class** Expenses: ObservableObject {

@Published **var** items = [ExpenseItem](){

**didSet** {

**if** **let** encoded = **try**? JSONEncoder().encode(items) {

UserDefaults.standard.set(encoded, forKey: "Items")

}

}

}

// Have an initializer that will read the values and load them into the items array

**init**(){

// Read the data from user defaults, if it exists

**if** **let** savedItems = UserDefaults.standard.data(forKey: "Items"){

// If the data exists, try to decode it

**if** **let** decodedItems = **try**? JSONDecoder().decode([ExpenseItem].**self**, from: savedItems){

items = decodedItems

**return**

}

}

// If it was not able to load the saved data, load an empty array

items = []

}

}

In the previous class, we create an array of ExpenseItems that we will use to store all the items of the list. This object is created here and shared with other views, like the AddView and the ContentView and that is why it has the @Published.

We’re going to leverage four important technologies to help us save and load data in a clean way:

* The **Codable** protocol, which will allow us to archive all the existing expense items ready to be stored.
* UserDefaults, which will let us save and load that archived data.
* A custom initializer for the Expenses class, so that when we make an instance of it we load any saved data from **UserDefaults**
* A **didSet** property observer on the items property of Expenses, so that whenever an item gets added or removed we’ll write out changes.

The AddView has the following code:

**struct** AddView: View {

// Observed an expense object passed to the view which will not be

// created here

@ObservedObject **var** expenses: Expenses

@Environment(\.dismiss) **var** dismiss

@State **private** **var** name = ""

@State **private** **var** type = "Personal"

@State **private** **var** amount = 0.0

**let** types = ["Business", "Personal"]

**var** body: **some** View {

NavigationView {

Form {

TextField("Name", text: $name)

Picker("Type", selection: $type) {

ForEach(types, id: \.**self**){

Text($0)

}

}

TextField("Amount", value: $amount, format: .currency(code: "USD"))

.keyboardType(.decimalPad)

}

.navigationTitle("Add new expense")

.toolbar {

Button("Save"){

**let** item = ExpenseItem(name: name, type: type, amount: amount)

expenses.items.append(item)

dismiss()

}

}

}

}

}

#Preview {

// For the preview, pass a dummy value

AddView(expenses: Expenses())

}

This is the screen we use to add a new item to the list. It will be shown every time the user clicks on plus button in the main screen (ContentView).

Some things to note in this view:

* We add an @ObservedObject to be able to work with the shared array.
* The @Environment property wrapper is used to execute the dismiss action of the view. This causes the **showingAddExpense** Boolean in **ContentView** to go back to false, and hides the **AddView**. To execute this, we just need to call the property dismiss() on the save button.
* We define a Form for the values of the expense item, and we add a Button to save it.
* In the Save button code, we call the dismiss property which will call the dismiss action for the view.
* The Preview code needs that we supply a dummy expenses object to be able to show the preview of the screen.

Finally, the main screen (ContentView) looks like this:

**struct** ContentView: View {

// Make an instance of expenses. The @StateObject asks SwiftUI

// to watch the object for any change announcements

@StateObject **var** expenses = Expenses()

@State **private** **var** showingAddExpense = **false**

// Get only business items

/\*var businessItems: [ExpenseItem] {

return expenses.items.filter { $0.type == "Business" }

}\*/

**var** body: **some** View {

NavigationView {

List {

Section("Business") {

ForEach(expenses.items , id: \.id) { item **in**

**if** item.type == "Business"{

HStack {

VStack {

Text(item.name)

.font(.headline)

.multilineTextAlignment(.leading)

Text(item.type)

.multilineTextAlignment(.leading)

}

.frame(maxWidth: .infinity, alignment: .leading)

Spacer()

Text(item.amount, format: .currency(code: Locale.current.currency?.identifier ?? "USD"))

.foregroundColor(getAmountColor(item.amount))

}

}

}

.onDelete(perform: removeItems)

}

Section("Personal") {

ForEach(expenses.items, id: \.id) { item **in**

**if** item.type == "Personal" {

HStack {

VStack {

Text(item.name)

.font(.headline)

.multilineTextAlignment(.leading)

Text(item.type)

.multilineTextAlignment(.leading)

}

.frame(maxWidth: .infinity, alignment: .leading)

Spacer()

Text(item.amount, format: .currency(code: Locale.current.currency?.identifier ?? "USD"))

.expenseStyle(for: item)

//.foregroundColor(getAmountColor(item.amount))

}

}

}

.onDelete(perform: removeItems)

}

}

.navigationTitle("iExpense")

.toolbar {

Button {

showingAddExpense = **true**

} label: {

Image(systemName: "plus")

}

}

.sheet(isPresented: $showingAddExpense){

AddView(expenses: expenses)

}

}

}

**func** getAmountColor(\_ amount: Double) -> Color {

**if** amount <= 10.0 {

**return** .green

} **else** **if** amount > 10 && amount <= 100 {

**return** .black

} **else** {

**return** .red

}

}

**func** removeItems(at offsets: IndexSet){

expenses.items.remove (atOffsets: offsets)

}

}

/\*\*

ViewModifier to define a specific style depending of the amount of the expense item

\*/

**struct** ExpenseStyle: ViewModifier {

**let** expenseItem: ExpenseItem

**func** body(content: Content) -> **some** View {

**switch** expenseItem.amount {

**case** 0..<10:

content

.foregroundColor(.green)

.bold()

**case** 10..<100:

content.foregroundColor(.black)

**default**:

content

.foregroundColor(.red)

.bold()

}

}

}

/\*\*

Extension to be able to use the expsnseStyle

\*/

**extension** View {

**func** expenseStyle(for expenseItem: ExpenseItem) -> **some** View {

modifier(ExpenseStyle(expenseItem: expenseItem))

}

}

Important things to note in this screen:

* The var expenses has a @StateObject because we are asking SwiftUI to watch for this object for any change.
* The button to add a new item is in the toolbar and what it does is to turn the showingAddExpense to true, this way, the .sheet is presented allowing the user to add the new item and we pass the expenses variable, the shared object that was created on the Expenses class.
* There are two foreach as we are separating the expense items in two sections for each type (business and personal). The list items are filtered by a simple if as if we use the filter modifier, we would be creating two different lists or arrays and the removeItem method will have issues locating the correct item to delete based on the index.
* The amounts have a different style based on the amount and using a ViewModifier and an extension.

# Project 08 - Moonshot

This section will give you more experience with Codable, Lists, Text and more while you learn more about making an image fit its space correctly.

## Resizing Images to Fit the Screen using GeometryReader

When we create an **Image** view in SwiftUI, it will automatically size itself according to the dimensions of its contents. This is sometimes what you want, but mostly you’ll want to show the image at a lower size.

When you load an image with the Image view, and even if you use the frame modifier to set a width and height, it could not fit and parts of the image may not be seen depending of the size of the image. If you use the resizable modifier makes thing better, but not enough, as the image may look squashed.

To make an image resize itself proportionally, you can use scaleToFit and scaleToFill modifiers.

All this works great if we want fixed-sized images, but very often you want images that automatically scale up to fill more of the screen in one or both dimensions. That is, rather than hard-coding a width of 300, what you *really* want to say is “make this image fill 80% of the width of the screen.” SwiftUI gives us a dedicated type for this called GeometryReader.

**GeometryReader** is a view just like the others we’ve used, except when we create it we’ll be handed a **GeometryProxy** object to use. This lets us query the environment: how big is the container? What position is our view? Are there any safe area insets? And so on.

In principle that seems simple enough, but in practice you need to use **GeometryReader** carefully because it automatically expands to take up available space in your layout, then positions its own content aligned to the top-left corner.

**struct** GeometryReaderExample: View {

**var** body: **some** View {

GeometryReader { geo **in**

Image("Landscape")

.resizable()

.scaledToFit()

.frame(width: geo.size.width \* 0.8)

// This second frame will contain the first one and will align it in the center

.frame(width: geo.size.width, height: geo.size.height)

}

}

}

We’ve given SwiftUI enough information that it can automatically figure out the height.

## How ScrollView lets us work with Scrolling Data

Scroll views can scroll horizontally, vertically, or in both directions, and you can also control whether the system should show scroll indicators next to them. When we place views inside scroll views, they automatically figure out the size of that content so users can scroll from one edge to the other.

**struct** CustomText: View {

**let** text: String

**var** body: **some** View {

Text(text)

}

**init**(\_ text: String){

print("Creating a new CustomText")

**self**.text = text

}

}

**struct** ScrollViewExample: View {

**var** body: **some** View {

ScrollView {

VStack(spacing: 10){

ForEach(0..<100){

CustomText("Item \($0)")

.font(.title)

}

}

.frame(maxWidth: .infinity)

}

}

}

With this code you can see you can drag the scroll view around freely, and if you scroll to the bottom you’ll also see that **ScrollView** treats the safe area just like **List** and **Form.** This all seems really straightforward, however there’s an important catch that you need to be aware of: when we add views to a scroll view they get created immediately.

If you want to avoid this happening, there’s an alternative for both **VStack** and **HStack** called **LazyVStack** and **LazyHStack** respectively. These can be used in exactly the same way as regular stacks but will load their content on-demand – they won’t create views until they are actually shown, and so minimize the amount of system resources being used.

**struct** ScrollViewExample: View {

**var** body: **some** View {

ScrollView(.vertical) {

LazyVStack(spacing: 10){

ForEach(0..<100){

CustomText("Item \($0)")

.font(.title)

}

}

.frame(maxWidth: .infinity)

}

}

}

Lazy stacks always take up as much as room as is available in our layouts, whereas regular stacks take up only as much space as is needed. One last thing: you can make horizontal scrollviews by passing .horizontal as a parameter when you make your ScrollView. Once that’s done, make sure you create a horizontal stack or lazy stack, so your content is laid out as you expect.

## Pushing new views onto the stack using NavigationLink

SwiftUI’s **NavigationView** shows a navigation bar at the top of our views, but also does something else: it lets us push views onto a view stack.

This view stack system is very different from the sheets we’ve used previously. Yes, both show some sort of new view, but there’s a difference in the *way* they are presented that affects the way users think about them.

**struct** NavigationLinkExample: View {

**var** body: **some** View {

NavigationView {

List(0..<100) { row **in**

NavigationLink {

Text("Detail \(row)")

} label: {

Text("Row \(row)")

}

}

.navigationTitle("SwiftUI")

}

}

}

With NavigationLink, the user is going to see a list of 100 elements that indicates the Row and #, and it will show a chevron icon to show the user that this is a clickable item and when the user clicks on this icon, it will show another screen with Detail and row number.

We can use NavigationLink with any kind of destination view. Even better, you’ll see that the “SwiftUI” title animates down to become a back button, and you can tap that or swipe from the left edge to go back.

Both **sheet()** and **NavigationLink** allow us to show a new view from the current one, but the *way* they do it is different and you should choose them carefully:

* **NavigationLink** is for showing details about the user’s selection, like you’re digging deeper into a topic.
* **sheet()** is for showing unrelated content, such as settings or a compose window.

## Working with hierarchical Codable data

If you want to decode a complex JSON object, where you can find arrays inside other arrays, the codable protocol is capable of decoding everything but it is important to create separate types for each level you have.

In the next example you’ll see a button which will decode a simple JSON with the JSONDecoder but the important thing is that we have two structs, one for each level and they should conform the Codable protocol:

**struct** User: Codable {

**let** name: String

**let** address: Address

}

**struct** Address: Codable {

**let** street: String

**let** city: String

}

**struct** HierarchicalCodableData: View {

**var** body: **some** View {

Button("Decode JSON") {

**let** input = """

{

"name": "John Smith",

"address": {

"street": "555, Ever Green Avenue",

"city": "Nashville"

}

}

"""

**let** data = Data(input.utf8)

**if** **let** user = **try**? JSONDecoder().decode(User.**self**, from: data){

print(user.address.street)

}

}

}

}

## How to lay out views in a scrolling grid

When you need to show scrolling rows of data in columns, you need to use two views: LazyHGrid or LazyVGrid. Creating a grid is done in two steps. First, we need to define the rows or columns we want – we only define one of the two, depending on which kind of grid we want.

In the next example, we have a vertically scrolling grid, with three columns defined with 80 points wide each one.

**struct** ScrollingGridExample: View {

**let** layout = [

GridItem(.fixed(80)),

GridItem(.fixed(80)),

GridItem(.fixed(80))

]

**var** body: **some** View {

ScrollView {

LazyVGrid(columns: layout) {

ForEach(0..<1000) {

Text("Item \($0)")

}

}

}

}

}

Once you have your lay out defined, you should place your grid inside a **ScrollView**, along with as many items as you want. Each item you create inside the grid is automatically assigned a column in the same way that rows inside a list automatically get placed inside their parent.

Grids have the ability to work across a variety of screen sizes. You can also specify a maximum range for even more control and rely on the adaptive layouts. In the following example we are using an horizontal grid using rows instead of columns:

**struct** ScrollingGridExample: View {

**let** layout = [

GridItem(.adaptive(minimum: 80, maximum: 120))

]

**var** body: **some** View {

ScrollView(.horizontal){

LazyHGrid(rows: layout) {

ForEach(0..<1000) {

Text("Item \($0)")

}

}

}

}

}

## Loading a specific kind of Codable data

As part of the project, in this chapter we will load a couple of JSON files: one for the astronauts and the other for the mission’s information. Also, several images will be uploaded into the Assets folder.

To be able to work with the astronauts file, we have created the following Austronaut struct:

**struct** Astronaut: Codable, Identifiable {

**let** id: String

**let** name: String

**let** description: String

}

To load the files, we will create a Bundle-Decodable extension for the Bundle class. This is similar to the previous way to load JSON files, but with one difference: previously we used String(contentsOf:) to load files into a string, but because Codable uses Data we are instead going to use Data(contentsOf:). It works in just the same way as String(contentsOf:): give it a file URL to load, and it either returns its contents or throws an error.

**extension** Bundle {

// Function that reads a file and returns a dictionary of type [string, astronaut]

**func** decode(\_ file: String) -> [String: Astronaut] {

// Find that file in our installed app bundle

**guard** **let** url = **self**.url(forResource: file, withExtension: **nil**) **else** {

fatalError("Failed to locate \(file) in bundle.")

}

// If file was found, try to load it

**guard** **let** data = **try**? Data(contentsOf: url) **else** {

fatalError("Failed to load \(file) from bundle.")

}

// If it was loaded, decode it

**let** decoder = JSONDecoder()

**guard** **let** loaded = **try**? decoder.decode([String: Astronaut].**self**, from: data) **else** {

fatalError("Failed to decode \(file) from bundle.")

}

**return** loaded

}

}

With this extension, it takes only one code line to load a json file in the ContentView:

**struct** ContentView: View {

**let** astronauts = Bundle.main.decode("astronauts.json")

**var** body: **some** View {

Text("\(astronauts.count)")

.padding()

}

}

## Using Generics to Load any kind of Codable Data

The Bundle extension was specific for loading the JSON file for Astronauts, however, if we want to load any other kind of file, like the missions.json file, we need to do some changes. As the other file has a different structure, we will first start by creating a struct for the Crew Role and another one for the Mission:

**struct** Mission: Codable, Identifiable {

// Nested struct cause this is only being used by Mission struct

**struct** CrewRole: Codable {

**let** name: String

**let** role: String

}

**let** id: Int

**let** launchDate: String? //Optional property

**let** crew: [CrewRole]

**let** description: String

}

In the previous struct, we defined the properties for the Mission along with the nested struct for the crew role. It is important to note that the launchDate is optional as not all the missions have it.

For the Bundle extension, we start making the method generic by adding a placeholder for certain types, this is the <T> part:

**extension** Bundle {

// Function that reads a file and returns a dictionary of type [string, astronaut]

**func** decode<T: Codable>(\_ file: String) -> T {

// Find that file in our installed app bundle

**guard** **let** url = **self**.url(forResource: file, withExtension: **nil**) **else** {

fatalError("Failed to locate \(file) in bundle.")

}

// If file was found, try to load it

**guard** **let** data = **try**? Data(contentsOf: url) **else** {

fatalError("Failed to load \(file) from bundle.")

}

// If it was loaded, decode it

**let** decoder = JSONDecoder()

**guard** **let** loaded = **try**? decoder.decode(T.**self**, from: data) **else** {

fatalError("Failed to decode \(file) from bundle.")

}

**return** loaded

}

}

Then we need to replace the parts where we had the [String: Astronaut] with just T. If you try compiling this code, you’ll see an error in Xcode: “Instance method 'decode(\_:from:)' requires that 'T' conform to 'Decodable’”. What it means is that **T** could be anything: it could be a dictionary of astronauts, or it could be a dictionary of something else entirely. The problem is that Swift can’t be sure the type we’re working with conforms to the **Codable** protocol.

Fortunately we can fix this with a *constraint*: we can tell Swift that **T** can be whatever we want, as long as that thing conforms to **Codable**. That way Swift knows it’s safe to use, and will make sure we don’t try to use the method with a type that *doesn’t* conform to **Codable**.

Finally we need to update the ContentView to use a type annotation when we try to load the astronauts file and also for the missions file:

**struct** ContentView: View {

**let** astronauts: [String: Astronaut] = Bundle.main.decode("astronauts.json")

**let** missions: [Mission] = Bundle.main.decode("missions.json")

We just need to define the type of dictionary or type we will be using when we decode the files.

## Formatting our mission view

For this project, we will use some computed properties in the Mission struct to make it easier to display the values we want:

struct Mission: Codable, Identifiable {

// Nested struct cause this is only being used by Mission struct

struct CrewRole: Codable {

let name: String

let role: String

}

let id: Int

let launchDate: Date? //Optional property

let crew: [CrewRole]

let description: String

var displayName: String {

"Apollo \(id)"

}

var image: String {

"apollo\(id)"

}

var formattedLaunchDate: String {

launchDate?.formatted(date: .abbreviated, time: .omitted) ?? "N/A"

}

}

The displayName and image properties just make use of simple interpolation to display a string with a format we need. For the date, we first changed to Date type to use the formatted modifier. The formattedLaunchDate basically tries to give an abbreviate format to the launch date if it is not nil, otherwise, it will return “N/A”.

We will also create an extension of ShapeStyle for the color we want to use in the screen:

**import** Foundation

**import** SwiftUI

// Creates an extension of ShapeStyle only when we are extending Color

**extension** ShapeStyle **where** **Self** == Color {

**static** **var** darkBackground: Color {

Color(red: 0.1, green: 0.1, blue: 0.2)

}

**static** **var** lightBackground: Color {

Color(red: 0.2, green: 0.2, blue: 0.3)

}

}

**Color** conforms to a bigger protocol called **ShapeStyle** that is what lets us use colors, gradients, materials, and more as if they were the same thing. This ShapeStyle protocol is what the background() modifier uses, so what we really want to do is extend Color but do it in a way all the SwiftUI modifiers using ShapeStyle work too. That is why we use the where Self == Color, which means “we want to add functionality to ShapeStyle, but only for times when it’s being used as a color”.

You can also add colors to the asset catalog with specific names, which lets you work visually, but the extensions make it easier to monitor changes using something like GitHub.

The ContentView will look like this now:

**struct** ContentView: View {

**let** astronauts: [String: Astronaut] = Bundle.main.decode("astronauts.json")

**let** missions: [Mission] = Bundle.main.decode("missions.json")

**let** columns = [

GridItem(.adaptive(minimum: 150))

]

**var** body: **some** View {

NavigationView {

ScrollView {

LazyVGrid(columns: columns) {

ForEach(missions) { mission **in**

NavigationLink {

Text("Detail view")

} label: {

VStack {

Image(mission.image)

.resizable()

.scaledToFit()

.frame(width: 100, height: 100)

VStack {

Text(mission.displayName)

.font(.headline)

.foregroundColor(.white)

Text(mission.formattedLaunchDate)

.font(.caption)

.foregroundColor(.white.opacity(0.5))

}

.padding(.vertical)

.frame(maxWidth: .infinity)

.background(.lightBackground)

}

.clipShape(RoundedRectangle(cornerRadius: 10))

.overlay(

RoundedRectangle(cornerRadius: 10)

.stroke(.lightBackground)

)

}

}

}

.padding([.horizontal, .bottom])

}

.navigationTitle("Moonshot")

.background(.darkBackground)

.preferredColorScheme(.dark)

}

}

}

Things to note there:

* We are using a LazyVGrid and we define the columns to have adaptive grid items with a minimum 150 points of size.
* For each mission, we have a VStack as a label where we define an Image using the image computed property and defining a specific size of 100 x 100
* Then we define another VStack for the mission display name and formatted launch date. For them we are defining a specific font and foreground color.
* For the previous VStack we define a padding vertical, and use the lightBackground color we defined in the extension.
* For the main VStack we use the darkBackground and the dark scheme color.

## Showing Mission Details with ScrollView and GemetryReader

For the details view, we will display a screen with the information about the mission: its mission badge, mission description and all the astronauts that were on the crew along with their roles.

For the first two things, we have the following code:

**struct** MissionView: View {

**let** mission: Mission

**var** body: **some** View {

GeometryReader { geometry **in**

ScrollView {

VStack {

Image(mission.image)

.resizable()

.scaledToFit()

//Use only 60% of available width

.frame(maxWidth: geometry.size.width \* 0.60)

.padding(.top)

VStack(alignment: .leading) {

Text("Mission Highlights")

.font(.title.bold())

.padding(.bottom, 5)

Text(mission.description)

}

.padding(.horizontal)

}

.padding(.bottom)

}

}

.navigationTitle(mission.displayName)

.navigationBarTitleDisplayMode(.inline)

.background(.darkBackground)

}

}

We have a scrolling VStack with a resizable image for the mission badge, then a Text view for the highlights and another one for the description. We use GeometryReader to set the maximum width of the mission image, in this case, the 60% of the available width.

To be able to see the preview, we replace the #Preview chunk of code with this:

**struct** MissionView\_Previews: PreviewProvider {

**static** **let** missions: [Mission] = Bundle.main.decode("missions.json")

**static** **var** previews: **some** View {

MissionView(mission: missions[0])

.preferredColorScheme(.dark)

}

}

Basically, we load the missions and display the first one.

**Tip:** This view will automatically have a dark color scheme because it’s applied to the **NavigationView** in **ContentView**, but the **MissionView** preview doesn’t know that so we need to enable it by hand.

## Merging Codable structs

Below the mission description, we will show the information of the crew members.

As the astronauts information is in a separate file, we need to make use of the astronaut id to link the information to show.

In the MissionView, we have the next code:

**struct** MissionView: View {

**struct** CrewMember {

**let** role: String

**let** astronaut: Astronaut

}

**let** mission: Mission

**let** crew: [CrewMember]

**var** body: **some** View {

GeometryReader { geometry **in**

ScrollView {

VStack {

Image(mission.image)

.resizable()

.scaledToFit()

//Use only 60% of available width

.frame(maxWidth: geometry.size.width \* 0.60)

.padding(.top)

VStack(alignment: .leading) {

Rectangle()

.frame(height: 2)

.foregroundColor(.lightBackground)

.padding(.vertical)

Text("Mission Highlights")

.font(.title.bold())

.padding(.bottom, 5)

Text(mission.description)

Rectangle()

.frame(height: 2)

.foregroundColor(.lightBackground)

.padding(.vertical)

Text("Crew")

.font(.title.bold())

.padding(.bottom, 5)

}

.padding(.horizontal)

ScrollView(.horizontal, showsIndicators: **false**) {

HStack {

ForEach(crew, id: \.role) { crewMember **in**

NavigationLink {

Text("Astronat details")

} label: {

HStack {

Image(crewMember.astronaut.id)

.resizable()

.frame(width: 104, height: 72)

.clipShape(Capsule())

.overlay(

Capsule()

.strokeBorder(.white, lineWidth: 1, antialiased: **false**)

)

VStack(alignment: .leading) {

Text(crewMember.astronaut.name)

.foregroundColor(.white)

.font(.headline)

Text(crewMember.role)

.foregroundColor(.secondary)

}

}

.padding(.horizontal)

}

}

}

}

}

.padding(.bottom)

}

}

.navigationTitle(mission.displayName)

.navigationBarTitleDisplayMode(.inline)

.background(.darkBackground)

}

// Initialize the mission and crew structures

**init**(mission: Mission, astronauts: [String: Astronaut]){

**self**.mission = mission

**self**.crew = mission.crew.map { member **in**

// Find the astronauts from the crew in the astronauts info by name

**if** **let** astronaut = astronauts[member.name] {

**return** CrewMember(role: member.role, astronaut: astronaut)

} **else** {

fatalError("Missing \(member.name)")

}

}

}

}

**struct** MissionView\_Previews: PreviewProvider {

**static** **let** missions: [Mission] = Bundle.main.decode("missions.json")

**static** **let** astronauts: [String: Astronaut] = Bundle.main.decode("astronauts.json")

**static** **var** previews: **some** View {

MissionView(mission: missions[0], astronauts: astronauts)

.preferredColorScheme(.dark)

}

}

Things to note in this view:

* We created a nested struct for the CrewMember for the role and the data of the astronaut.
* A property called crew : [CrewMember] was created to store an array of CrewMember objects. To pair the data, we can loop over the mission crew, and for each crew member, look in the dictionary to find the one with the matching ID. If there is no match, then a fatal error is displayed. This is made on the init method.
* After that change, the preview struct is also updated to read the astronauts.json and pass that information into the mission view constructor.
* With the information available, we create a couple of “dividers” using the Rectangle view before the Mission Highlights and Crew titles.
* For the crew information, we have another ScrollView along with a HStack.
* We use another HStack to display the image and a VStack for the name and role of the astronaut. For the image, we use a specific size using frame and the clipShape and overlay to give it a specific form and highlight the border.
* The ScrollView is after the VStack because they work best when they take full advantage of the available screen space.

In the ContentView, for the NavigationLink, now we have the following ode to show the MissionView screen:

NavigationLink {

MissionView(mission: mission, astronauts: astronauts)

}

## Finishing up with one last view

To finish the application, we will add a third view to display astronaut details. This is the AstronautView:

**struct** AstronautView: View {

**let** astronaut: Astronaut

**var** body: **some** View {

ScrollView {

VStack {

Image(astronaut.id)

.resizable()

.scaledToFit()

Text(astronaut.description)

.padding()

}

}

.background(.darkBackground)

.navigationTitle(astronaut.name)

.navigationBarTitleDisplayMode(.inline)

}

}

**struct** AstronautView\_Previews: PreviewProvider {

**static** **let** astronauts: [String: Astronaut] = Bundle.main.decode("astronauts.json")

**static** **var** previews: **some** View {

AstronautView(astronaut: astronauts["armstrong"]!)

}

}

This is a simpler screen than the others as it only has a ScrollView with a VStack to show the image of the astronaut, using the available space and the description of the astronaut.

Again, for the preview, we need to decode the information from astronauts.json and in this case, select a specific item and as it is marked as optional, we use the !.

# Project 09 - Drawing

In this technique project we’re going to take a close look at drawing in SwiftUI, including creating custom paths and shapes, animating your changes, solving performance problems, and more – it’s a really big topic, and deserves close attention.

SwiftUI uses the same drawing system that we have on the rest of Apple’s frameworks: Core Animation and Metal. Most of the time Core Animation is responsible for our drawing, whether that’s custom paths and shapes or UI elements such as **TextField**, but when things really get complex we can move down to Metal – Apple’s low-level framework that’s optimized for complex drawing. One of the neat features of SwiftUI is that these two are almost interchangeable: we can move from Core Animation to Metal with one small change.

## Creating custom paths with SwiftUI

SwiftUI gives us a dedicated **Path** type for drawing custom shapes. It’s very low level. Just like colors, gradients, and shapes, paths are views in their own right. This means we can use them just like text views and images.

**struct** CustomPathEx: View {

**var** body: **some** View {

Path { path **in**

path.move(to: CGPoint(x: 200, y: 100))

path.addLine(to: CGPoint(x: 100, y: 300))

path.addLine(to: CGPoint(x: 300, y: 300))

path.addLine(to: CGPoint(x: 200, y: 100))

path.closeSubpath() //Indicates this is the end of the path

}

//.fill(.red) //This is a way to color the figure

//.stroke(.blue, lineWidth: 10)

.stroke(.blue, style: StrokeStyle(lineWidth: 10, lineCap: .round, lineJoin: .round))

}

}

In the example above, we have built a triangle using a Path and defining an initial starting point with the move modifier and adding lines with the addLine modifier. Paths have lots of methods for creating shapes with squares, circles, arcs, and lines.

CG is short for Core Graphics, which provides a selection of basic types that lets us reference X/Y coordinates (**CGPoint**), widths and heights (**CGSize**), and rectangular frames (**CGRect**).

We can fill the triangle with the .fill modifier. We can also use the stroke() modifier to draw around the path rather than filling it in. The closeSubpath() is used to indicate that it is the end of the path.

An alternative is to use SwiftUI’s dedicated **StrokeStyle** struct, which gives us control over how every line should be connected to the line after it (line join) and how every line should be drawn when it ends without a connection after it (line cap). This is particularly useful because one of the options for join and cap is **.round**, which creates gently rounded shapes

## Paths vs shapes in SwiftUI

SwiftUI enables custom drawing with two types: paths and shapes:

* A path is a series of drawing instructions such as “start here, draw a line to here, then add a circle there”, all using absolute coordinates.
* A shape has no idea where it will be used or how big it will be used, but instead will be asked to draw itself inside a given rectangle.

SwiftUI implements Shape as a protocol with a single required method: path to draw.

**struct** Triangle: Shape {

**func** path(in rect: CGRect) -> Path {

**var** path = Path()

path.move(to: CGPoint(x: rect.midX, y: rect.minY))

path.addLine(to: CGPoint(x: rect.minX, y: rect.maxY))

path.addLine(to: CGPoint(x: rect.maxX, y: rect.maxY))

path.addLine(to: CGPoint(x: rect.midX, y: rect.minY))

**return** path

}

}

**struct** Arc: Shape {

**let** startAngle: Angle

**let** endAngle: Angle

**let** clockwise: Bool

**func** path(in rect: CGRect) -> Path {

**let** rotationAdjustment = Angle.degrees(90)

**let** modifiedStart = startAngle - rotationAdjustment

**let** modifiedEnd = endAngle - rotationAdjustment

**var** path = Path()

path.addArc(center: CGPoint(x: rect.midX, y: rect.midY), radius: rect.width / 2, startAngle: modifiedStart, endAngle: modifiedEnd, clockwise: !clockwise)

**return** path

}

}

**struct** ShapesAndPaths: View {

**var** body: **some** View {

Arc(startAngle: .degrees(0), endAngle: .degrees(110), clockwise: **true**)

.stroke(.blue, lineWidth: 10)

.frame(width: 300, height: 300)

Triangle()

//.fill(.red)

.stroke(.red, style: StrokeStyle(lineWidth: 10, lineCap: .round, lineJoin: .round))

.frame(width: 300, height: 300)

}

}

In the previous example, we have 2 Shapes, one for a Triangle and one for an Arc.

By using the CGRect you have some helpful properties like minx (smalles X value in the rectangle), maxX (largest X value in the rectangle), midX (mid-point between minX and maxX)

By calling the Triangle shape, we can use the stroke modifier and give it a specific size with the frame modifier.

In the case of the Arc shape, we define 3 properties (startAngle, endAngle and clockwise to specify the rotation). There are a couple of things to take into consideration:

1. In the eyes of SwiftUI, 0 degrees is not straight upwards, but instead directly to the right.
2. Shapes measure their coordinates from the bottom-left corner rather than the top-left corner, which means SwiftUI goes the other way around from one angle to the other. This is, in my not very humble opinion, extremely alien.

So, to create an Arc starting from the top of the rectangle, we defined the rotationAdjustment and the modifiedStart and modifiedEnd.

## Adding strokeBorder() support with InsettableShape

If you create a shape without a specific size, it will automatically expand to occupy all available space.

If you use stroke modifier without defining the size of the shape, you may see the edges of the border are cut off, you can avoid this by using .strokeBorder modifier.

When you use a custom shape, like the Arc shape defined previously, and try to use strokeBorder, it will not be found, because this modifier is part of the InsettableShape protocol. This protocol allows a shape to be inset (reduced inwards), by a certain amount.

**struct** Arc: **InsettableShape** {

**let** startAngle: Angle

**let** endAngle: Angle

**let** clockwise: Bool

**var** insetAmount = 0.0

**func** path(in rect: CGRect) -> Path {

**let** rotationAdjustment = Angle.degrees(90)

**let** modifiedStart = startAngle - rotationAdjustment

**let** modifiedEnd = endAngle - rotationAdjustment

**var** path = Path()

path.addArc(center: CGPoint(x: rect.midX, y: rect.midY), radius: rect.width / 2 - insetAmount, startAngle: modifiedStart, endAngle: modifiedEnd, clockwise: !clockwise)

**return** path

}

**func** inset(by amount: CGFloat) -> **some** InsettableShape {

**var** arc = **self**

arc.insetAmount += amount

**return** arc

}

}

So, to make the previous Arc shape an insettable shape, we must add a property (insetAmount), for this shape, use it for the radius, add the inset method which will use a CGFloat parameter and conform the InsettableShape.

Then, we can use it like this:

Arc(startAngle: .degrees(-90), endAngle: .degrees(90), clockwise: **true**)

.strokeBorder(.blue, lineWidth: 40)

## Transforming shapes using CGAffineTransform and even-odd fills

SwiftUI offers the CGAffineTransform that describes how a path or view should be rotated, scaled or sheared.

There are also the even-odd fills, that allows us to control how overlapping shapes should be rendered.

In the following example, we are going to create a Flower shape out of several rotated ellipse petals, with each ellipse positioned around a circle. There is one important note about CGAffineTransform: it measures angles in radians rather than degrees but 3.141 radians is equal to 180 degrees, so 3.141 radians multiplied by 2 is equal to 360 degrees.

This is the code:

**struct** Flower: Shape {

**var** petalOffset = -20.0

**var** petalWidth = 100.0

**func** path(in rect: CGRect) -> Path {

**var** path = Path()

**for** number **in** stride(from: 0, to: Double.pi \* 2, by: Double.pi / 8){

**let** rotation = CGAffineTransform(rotationAngle: number)

**let** position = rotation.concatenating(CGAffineTransform(translationX: rect.width / 2, y: rect.height / 2))

**let** originalPetal = Path(ellipseIn: CGRect(x: petalOffset, y: 0, width: petalWidth, height: rect.width / 2))

**let** rotatedPetal = originalPetal.applying(position)

path.addPath(rotatedPetal)

}

**return** path

}

}

**struct** TransformShapes: View {

@State **private** **var** petalOffset = -20.0

@State **private** **var** petalWidth = 100.0

**var** body: **some** View {

VStack {

Flower(petalOffset: petalOffset, petalWidth: petalWidth)

//.stroke(.red, lineWidth: 1)

.fill(.red, style: FillStyle(eoFill: **true**))

Text("Offset")

Slider(value: $petalOffset, in: -40...40)

.padding([.horizontal, .bottom])

Text("Width")

Slider(value: $petalWidth, in: 0...100)

.padding(.horizontal)

}

}

}

This is what it does:

* A new path is created.
* We count from 0 up to pi multiplied by 2 to complete the circle, counting in one eighth of pi each time – this will give us 16 petals.
* We create a rotation transform equal to the current number.
* Add to that rotation a movement equal to half the width and height of our draw space, so each petal is centered in our shape.
* Create a *new* path for a petal, equal to an ellipse of a specific size.
* Apply our transform to that ellipse so it’s moved into position.
* Add that petal’s path to our main path.

1. Rotating something then moving it does not produce the same result as moving then rotating, because when you rotate it first the direction it moves will be different from if it were not rotated.

2. To really help you understand what’s going on, we’ll be making our petal ellipses use a couple of properties we can pass in externally.

3. Ranges such as 1...5 are great if you want to count through numbers one a time, but if you want to count in 2s, or in our case count in “pi/8”s, you should use stride(from:to:by:) instead.

In the fill modifier for the Flower shape in the main struct, we use the FillStyle eoFill in true, this is the even-odd rule, which decides whether part of a path should be colored depending on the overlaps it contains: It works like this:

* If a path has no overlaps it will be filled.
* If another path overlaps it, the overlapping part won’t be filled.
* If a third path overlaps the previous two, then it will be filled.
* ...and so on.

Only the parts that actually overlap are affected by this rule.

## Creative borders and fills using ImagePaint

SwiftUI gives us a dedicated type that wraps images in a way that we have complete control over how the images should be rendered. This allows us to use them for borders and fills without problem.

The type is called **ImagePaint**, and it’s created using one to three parameters. At the very least you need to give it an **Image** to work with as its first parameter, but you can also provide a rectangle within that image to use as the source of your drawing specified in the range of 0 to 1 (the second parameter), and a scale for that image (the third parameter).

If you want to try using the **sourceRect** parameter, make sure you pass in a **CGRect** of relative sizes and positions: 0 means “start” and 1 means “end”. For example, this will show the entire width of our example image, but only the middle half:

Text("Hello World")

.frame(width: 300, height: 300)

.border(ImagePaint(image: Image("mountain"), sourceRect: CGRect(x: 0, y: 0.25, width: 1, height: 0.5), scale: 0.1), width: 30)

It’s worth adding that **ImagePaint** can be used for view backgrounds and also shape strokes. For example, we could create a capsule with our example image tiled as its stroke:

Capsule()

.strokeBorder(ImagePaint(image: Image("mountain"), sourceRect: CGRect(x: 0, y: 0.25, width: 1, height: 0.5), scale: 0.2), lineWidth: 20)

.frame(width: 300, height: 200)

**ImagePaint** will automatically keep tiling its image until it has filled its area – it can work with backgrounds, strokes, borders, and fills of any size.

## Enabling high-performance Metal rendering with drawingGroup()

SwiftUI uses Core Animation for its rendering by default, which offers great performance out of the box. However, for complex rendering you might find your code starts to slow down. The next example will demonstrate t by creating a color-cycling view that renders concentric circles in a range of colors.

We can get a color cycling effect by using the **Color(hue:saturation:brightness:)** initializer: hue is a value from 0 to 1 controlling the kind of color we see – red is both 0 and 1, with all other hues in between. To figure out the hue for a particular circle we can take our circle number (e.g. 25), divide that by how many circles there are (e.g. 100), then add our color cycle amount (e.g. 0.5). So, if we were circle 25 of 100 with a cycle amount of 0.5, our hue would be 0.75.

One small complexity here is that hues don’t automatically wrap after we reach 1.0, which means a hue of 1.0 is equal to a hue of 0.0, but a hue of 1.2 is *not* equal to a hue of 0.2. As a result, we’re going to wrap the hue by hand: if it’s over 1.0 we’ll subtract 1.0, to make sure it always lies in the range of 0.0 to 1.0.

**struct** ColorCyclingCircle: View {

**var** amount = 0.0

**var** steps = 100

**var** body: **some** View {

ZStack {

ForEach(0..<steps) { value **in**

Circle()

.inset(by: Double(value))

.strokeBorder(

LinearGradient(gradient: Gradient(colors: [

color(for: value, brightness: 1),

color(for: value, brightness: 0.5)

]), startPoint: .top, endPoint: .bottom),

lineWidth: 2

)

}

}

}

**func** color(for value: Int, brightness: Double) -> Color {

**var** targetHue = Double(value) / Double(steps) + amount

**if** targetHue > 1 {

targetHue -= 1

}

**return** Color(hue: targetHue, saturation: 1, brightness: brightness)

}

}

**struct** DrawingGroupEx: View {

@State **private** **var** colorCycle = 0.0

**var** body: **some** View {

VStack {

ColorCyclingCircle(amount: colorCycle)

.frame(width: 300, height: 300)

Slider(value: $colorCycle)

}

}

}

That now renders a gentle gradient, showing bright colors at the top of the circle down to darker colors at the bottom. And *now* when you run the app you’ll find it runs much slower –

SwiftUI is struggling to render 100 gradients as part of 100 separate views.

We can fix this by using the modifier drawingGroup() in the VStack:

**var** body: **some** View {

ZStack {

ForEach(0..<steps) { value **in**

Circle()

.inset(by: Double(value))

.strokeBorder(

LinearGradient(gradient: Gradient(colors: [

color(for: value, brightness: 1),

color(for: value, brightness: 0.5)

]), startPoint: .top, endPoint: .bottom),

lineWidth: 2

)

}

}

**.drawingGroup()**

}

This tells SwiftUI it should render the contents of the view into an off-screen image before putting it back onto the screen as a single rendered output, which is significantly faster. This is powered by Metal, an Apple’s framework for working directly with the GPU for extremely fast graphics.

**Important:** The **drawingGroup()** modifier is helpful to know about and to keep in your arsenal as a way to solve performance problems when you hit them, but you should *not* use it that often. Adding the off-screen render pass might slow down SwiftUI for simple drawing, so you should wait until you have an actual performance problem before trying to bring in **drawingGroup()**.

## Special effects in SwiftUI: blurs, blending, and more

You can apply blend modes to control the way one view is rendered on top of another. For example:

**struct** SpecialEffectsEx: View {

**var** body: **some** View {

ZStack {

Image("mountain")

Rectangle()

.fill(.green)

.**blendMode**(.multiply)

}

}

}

In the previous example, we use the blendMode(.multiply). It multiplies each source pixel color with the destination pixel color – in our case, each pixel of the image and each pixel of the rectangle on top. Each pixel has color values for RGBA, ranging from 0 (none of that color) through to 1 (all of that color), so the highest resulting color will be 1x1, and the lowest will be 0x0.

This is so common, that it has a shortcut:

Image("mountain")

.colorMultiply.(blue)

Another popular effect is called *screen*, which does the opposite of multiply: it inverts the colors, performs a multiply, then inverts them again, resulting in a brighter image rather than a darker image.

VStack {

ZStack {

Circle()

.fill(Color(red: 1, green: 0, blue: 0))

.frame(width: 200 \* amount)

.offset(x: -50, y: -80)

.blendMode(.screen)

Circle()

.fill(Color(red: 0, green: 1, blue: 0))

.frame(width: 200 \* amount)

.offset(x: 50, y: -80)

.blendMode(.screen)

Circle()

.fill(Color(red: 0, green: 0, blue: 1))

.frame(width: 200 \* amount)

.blendMode(.screen)

}

.frame(width: 300, height: 300)

Slider(value: $amount)

.padding()

}

.frame(maxWidth: .infinity, maxHeight: .infinity)

.background(.black)

.ignoresSafeArea()

SwiftUI use adaptive by default, which are designed to look good in both dark mode and light mode, so they are custom blend, but if you want the full effect, you need to use the Color view and specify the values for red, green and blue:

Color(red: 1, green: 0, blue: 0))

There is another effect called saturation, which adjusts how much color is used inside a view:

@State **private** **var** amount = 0.0

**var** body: **some** View {

VStack {

Image("mountain")

.resizable()

.frame(width: 200, height: 200)

.**saturation**(amount)

.**blur**(radius: (1 - amount) \* 20)

Slider(value: $amount)

.padding()

}

}

With that code, having the slider at 0 means the image is blurred and colorless, but as you move the slider to the right it gains color and becomes sharp – all rendered at lightning-fast speed.

## Animating simple shapes with animatableData

struct Trapezoid: Shape {

var insetAmount: Double

var animatableData: Double {

get { insetAmount }

set { insetAmount = newValue }

}

func path(in rect: CGRect) -> Path {

var path = Path()

path.move(to: CGPoint(x: 0, y: rect.maxY))

path.addLine(to: CGPoint(x: insetAmount, y: rect.minY))

path.addLine(to: CGPoint(x: rect.maxX - insetAmount, y: rect.minY))

path.addLine(to: CGPoint(x: rect.maxX, y: rect.maxY))

path.addLine(to: CGPoint(x: 0, y: rect.maxY))

return path

}

}

struct AnimatableData: View {

@State private var insetAmount = 50.0

var body: some View {

Trapezoid(insetAmount: insetAmount)

.frame(width: 200, height: 100)

.onTapGesture {

withAnimation{

insetAmount = Double.random(in: 10...90)

}

}

}

}

In the example above, we define a Trapezoid shape, which uses a property called insetAmount to define the longitude of the top line of the trapezoid.

In the body of the View, where we define the shape, we are modifying that property every time the users taps on it with the onTapGesture modifier. Every time you tap the trapezoid, insetAmount gets set to a new value, causing the shape to be redrawn.

The animation is not working without the animatableData property because as soon as **insetAmount** is set to a new random value, it will immediately jump to that value and pass it directly into **Trapezoid** – it won’t pass in lots of intermediate values as the animation happens. This is why our trapezoid jumps from inset to inset; it has no idea an animation is even happening.

The property anitmatableData fixes this. when we use **withAnimation()**, SwiftUI immediately changes our state property to its new value, but behind the scenes it’s also keeping track of the changing value over time as part of the animation. As the animation progresses, SwiftUI will set the **animatableData** property of our shape to the latest value, and it’s down to us to decide what that means – in our case we assign it directly to **insetAmount**, because that’s the thing we want to animate.

## Animating complex shapes with AnimatablePair

AnimatableData property allows us to animate changes to shapes, but this a property, which means it must always be one value, however we can use a special wrapper called AnimatablePair to work with a pair of values.

Having this code, where we build a Checkerboard of 4x4 initially, we want to make it of 8 rows by 16 columns when we tap on it, with an animation of 3 seconds long:

struct Checkerboard: Shape {

var rows: Int

var columns: Int

func path(in rect: CGRect) -> Path {

var path = Path()

// figure out how big each row/column needs to be

let rowSize = rect.height / Double(rows)

let columnSize = rect.width / Double(columns)

// loop over all rows and columns, making alternating squares colored

for row in 0..<rows {

for column in 0..<columns {

// Decide if the square is colored by identifying if it is multiple of 2

if (row + column).isMultiple(of: 2) {

// this square should be colored; add a rectangle here

let startX = columnSize \* Double(column)

let startY = rowSize \* Double(row)

// Draw the square

let rect = CGRect(x: startX, y: startY, width:

columnSize, height: rowSize)

path.addRect(rect)

}

} }

return path }

}

struct AnimatablePairEx: View {

@State private var rows = 4

@State private var columns = 4

var body: some View {

Checkerboard(rows: rows, columns: columns)

.onTapGesture {

withAnimation(.linear(duration: 3)){

rows = 8

columns = 16

}

}

}

}

However, when we tap on the checkerboard, the change is made at once, without any animation. There are two problems here:

1. We have two properties that we want to animate, not one.

2. Our row and column properties are integers, and SwiftUI can’t interpolate integers.

For the first problem, we use AnimatablePair. We can read individual values from the pair using .first and .second.

To resolve the *second* problem we’re just going to do some type conversion: we can convert a **Double** to an **Int** just by using **Int(someDouble)**, and go the other way by using **Double(someInt)**.

So, we just need to add a property to the Checkerboard shape for solve these two problems:

struct Checkerboard: Shape {

var rows: Int

var columns: Int

**var animatableData: AnimatablePair<Double, Double> {**

**get {**

**AnimatablePair(Double(rows), Double(columns))**

**}**

**set {**

**rows = Int(newValue.first)**

**columns = Int(newValue.second)**

**}**

**}**

# Project 10 – Cupcake Corner

In this project we’re going to build a multi-screen app for ordering cupcakes. This will use a couple of forms, which are old news for you, but you’re also going to learn how to make classes conform to Codable when they have @Published properties, how to send and receive the order data from the internet, how to validate forms, and more.

## Adding Codable conformance for @Published properties

If all the properties of a type already conform to **Codable**, then the type itself can conform to **Codable** with no extra work – Swift will synthesize the code required to archive and unarchive your type as needed. However, this *doesn’t* work when we use property wrappers such as **@Published**, which means conforming to **Codable** requires some extra work on our behalf.

To fix this, we need to implement **Codable** conformance ourself.

**class** User: ObservableObject, Codable {

@Published **var** name = "Esteban"

}

In the previous code, the property wrapper comes from the fact that our name property is automatically wrapped inside another type that adds some additional functionality. In the case of @Published, that’s a struct called Published that can store any kind of value.

You cannot make an instance of Published by itself, but instead make an instance of Published<String> for example. It is the same that happens with Set, arrays and dictionaries.

Swift already has rules in place that say if an array contains **Codable** types then the whole array is **Codable**, and the same for dictionaries and sets. However, SwiftUI *doesn’t* provide the same functionality for its **Published** struct

We need to tell Swift which properties should be loaded and saved, and how to do both of those actions.

This is done using an enum that conforms to a special protocol called **CodingKey**, which means that every case in our enum is the name of a property we want to load and save. The convention is to call the enum CodingKeys.

Then, we need to create a custom initializer that will be given some sort of container and use that to read values for all our properties. First, this initializer is handed an instance of a new type called Decoder. This contains all our data, but it’s down to us to figure out how to read it.

Second, anyone who subclasses our **User** class must override this initializer with a custom implementation to make sure they add their own values. We mark this using the **required** keyword.

Third, inside the method we ask our **Decoder** instance for a container matching all the coding keys we already set in our **CodingKey** struct by writing **decoder.container(keyedBy: CodingKeys.self)**. This means “this data should have a container where the keys match whatever cases we have in our **CodingKeys** enum.

Finally, we can read values directly from that container by referencing cases in our enum – **container.decode(String.self, forKey: .name)**. This provides really strong safety in two ways: we’re making it clear we expect to read a string and we’re also using a case in our CodingKeys enum rather than a string.

There is one more task to do before User class conforms to Codable: we need to tell Swift how to encode this type, how to archive it ready to write to JSON. In this function we need an encoder instance to write to, ask it to make a container using our CodingKeys enum for keys, then write our values attached to each key.

**class** User: ObservableObject, Codable {

**enum** CodingKeys: CodingKey {

**case** name

}

@Published **var** name = "Esteban"

**required** **init**(from decoder: Decoder) **throws** {

**let** container = **try** decoder.container(keyedBy: CodingKeys.**self**)

name = **try** container.decode(String.**self**, forKey: .name)

}

**func** encode(to encoder: Encoder) **throws** {

**var** container = encoder.container(keyedBy: CodingKeys.**self**)

**try** container.encode(name, forKey: .name)

}

}

## Sending and receiving Codable data with URLSession and SwiftUI

With the built-in tools for sending and receiving data from internet combined with the Codable support, we can convert Swift objects to JSON and vice versa and assign the data immediately to the UI.

**struct** Response: Codable {

**var** results: [Result]

}

**struct** Result: Codable {

**var** trackId: Int

**var** trackName: String

**var** collectionName: String

}

**struct** \_2\_UrlSessionExample: View {

@State **private** **var** results = [Result]()

**var** body: **some** View {

List(results, id: \.trackId) { item **in**

VStack(alignment: .leading) {

Text(item.trackName)

.font(.headline)

Text(item.collectionName)

}

}

.task {

**await** loadData()

}

}

**func** loadData() **async** {

// 1. Define the url

**guard** **let** url = URL(string: "https://itunes.app.com/search=mudvayne&entity=song")

**else** {

// If it fails to get the information, print message and exit. It should not fail

print("Invalid URL")

**return**

}

// 2. Fetch data from url

**do** {

**let** (data, \_) = **try** **await** URLSession.shared.data(from: url)

**if** **let** decodedResponse = **try**? JSONDecoder().decode(Response.**self**, from: data){

results = decodedResponse.results

}

} **catch** {

print("Invalid data")

}

}

}

The Result struct represents part of the information returned by Apple’s API, the Response struct will store an array of results.

The content view (\_2\_UrlSessionExample) shows a list with the track name and the collection name. To load this list, we need to use a **task**.

An Asynchronous function allows you to leave some code running while the main app code carries on working. This is useful when you have networking work to do, like downloading data from internet. While we are downloading the data, the rest of the app doesn’t freeze up.

The loadData function uses the **async** keyword to denote that this function might want to go to sleep in order to complete its work.

We want that to be run as soon as our **List** is shown, but we can’t just use **onAppear()** here because that doesn’t know how to handle sleeping functions – it expects its function to be synchronous. To do this, we use task(). The task is used to call functions that might go to sleep for a while. To call an async function inside task, we need to use **await** before the task.

Tip: Think of **await** as being like try – we’re saying we understand a sleep might happen, in the same way try says we acknowledge an error might be thrown.

Inside loadData() we have three steps we need to complete:

1. Creating the URL we want to read. For this, we use guard let… to guarantee that the URL is well constructed, if it is not, an error will be printed, and the process will end.
2. Fetching the data for that URL. Here is where the sleep is likely to happen. Every time a sleep is possible, we need to use await and as an error might happen too, you need try too.

There are some important things in the part:

* 1. The data(from:) method, takes a URL and returns the Data object at that URL. This method belongs to the **URLSession** class, which you can create and configure by hand if you want, but you can also use a shared instance that comes with sensible defaults.
  2. The return value from data(from:) is a tuple containing the data at the URL and some metadata describing how the request went. We don’t use the metadata, but we do want the URL’s data, hence the underscore – we create a new local constant for the data, and toss the metadata away.
  3. When using both try and await at the same time, we must write try await, in that order.

1. Decoding the result of that data into a Response struct. We use the JSONDecoder for this.

## Loading an image from a remote server

When you need to load an image from Internet, instead of using an Image view, you need to use a AsyncImage. This view use an image URL instead of a asset name.

The simplest image we can create looks like this:

AsyncImage(url: URL(string: "https://hws.dev/img/logo.png"))

As the image has to be downloaded, SwiftUI knows nowthing about it, so, it is not able to size it properly ahead of time. We can use the scale property to tell it to scale the image, for example, to 3x:

AsyncImage(url: URL(string: "https://hws.dev/img/logo.png"), scale: 3)

If you want a specific size, you need a more advance form of the AsyncImage that passes the final image view once it’s ready, which we can then customize as needed.

AsyncImage(url: URL(string: "https://hws.dev/img/logo.png"))

{ image **in**

image

.resizable()

.scaledToFit()

} placeholder: {

Color.red

}

.frame(width: 200, height: 200)

The red color for the place holder is just to allow us to see the placeholder before it loads the image. A resizable image and Color.red both automatically take up all available space, which means the frame() modifier actually works now.

Another way of creating a AsyncImage that gives you more control is the following, where we can show an error if something doesn’t allow us to load the image

struct \_3\_AsyncImageExample: View {

var body: some View {

AsyncImage(url: URL(string: "https//hws.dev/img/logo.png")) { phase **in**

**if** **let** image = phase.image {

image

.resizable()

.scaledToFit()

} **else** **if** phase.error != **nil** {

Text("There was an error loading the image.")

} **else** {

ProgressView()

}

}

.frame(width: 200, height: 200)

}

}

## Validating and disabling forms

The modifier disabled() allow us to use a condition to disable a view. You can use simple properties or methods for this condition. In the following example, we define a Form for a username and an email, and a Button that will be available only if both texts have more than 5 characters:

**struct** \_4\_ValidateForms: View {

@State **private** **var** username = ""

@State **private** **var** email = ""

**var** body: **some** View {

Form {

Section {

TextField("Username", text: $username)

TextField("Email", text: $email)

}

Section {

Button("Create account") {

print("Creating account...")

}

}

//.disabled(username.isEmpty || email.isEmpty)

.disabled(disableForm)

}

}

**var** disableForm: Bool {

username.count < 5 || email.count < 5

}

}

In the previous example, we are using a method but we chan use a validation in the same disabled modifier.

## Taking basic order details - Project

The first thing we will do is to create an ordering screen. First, we need to define a data model using @State for simple values and @StateObject for reference types. We will have a single class that stores all the data, which will be passed from screen to screen. This means all screens in the app share the same data.

The first class to be created is the Order class:

**class** Order: ObservableObject {

**static** **let** types = ["Vanilla", "Strawberry", "Chocolate", "Rainbow"]

@Published **var** type = 0

@Published **var** quantity = 3

@Published **var** specialRequestEnabled = **false** {

**didSet** {

**if** specialRequestEnabled == **false** {

extraFrosting = **false**

addSprinkles = **false**

}

}

}

@Published **var** extraFrosting = **false**

@Published **var** addSprinkles = **false**

}

This class conforms to ObservableObject and it has several properties like the types of cakes (an static array with the possible options), a type which will use an index of the types, the quantity, whether the user wants to make special requests (in this case, when the value is set to false, we will do the same for the other two properties (extraFrosting and add Sprinkles)), whether the user wants extra frosting and whether the user wants to add sprinkles. Each of these properties need to update the UI when changed, which means we need to mark them with @Published.

Now, in the ContentView we create a single instance of Order.

**struct** ContentView: View {

// This will be the only place in the application where the object will be created

@StateObject **var** order = Order()

**var** body: **some** View {

NavigationView {

Form {

Section {

Picker("Select your cake type", selection: $order.type) {

ForEach(Order.types.indices) {

Text(Order.types[$0])

}

}

Stepper("Number of cakes: \(order.quantity)", value: $order.quantity, in: 3...20)

}

Section {

Toggle("Any special requests?", isOn: $order.specialRequestEnabled.animation())

**if** order.specialRequestEnabled {

Toggle("Add extra frosting", isOn: $order.extraFrosting)

Toggle("Add extra sprinkles", isOn: $order.addSprinkles)

}

}

Section {

NavigationLink {

AddressView(order: order)

} label: {

Text("Deliver details")

}

}

}

.navigationTitle("Cupcake Corner")

}

}

}

The ContentView has 3 sections:

* The first one allows the user to select the type of cake and the number of cakes. We use the type property and the indices from types to display and select the type of cake.
* The second has a toggle for the special requests and if this one is on, it will show the extra frosting and sprinkles toggles.
* The last section hast a navigatin link for the AddressView.

There’s a small speed bump here: our cupcake topping list is an array of strings, but we’re storing the user’s selection as an integer – how can we match the two? One easy solution is to use the indices property of the array, which gives us a position of each item that we can then use with as an array index. This is a bad idea for mutable arrays because the order of your array can change at any time, but here our array order won’t ever change so it’s safe.

The AddresView will have an order observed object property like this:

**struct** AddressView: View {

@ObservedObject **var** order: Order

**var** body: **some** View {

Text("Hello, World”)

}

}

The AddressView will be updated later.

## Checking for a valid address - Project

The second step in the project is to let the user enter a valid address.

The first thing to do is add a CheckoutView, which will be the next step once the address is ready. We will come to this view with another navigation link. This will have so far, just the same Order observed object:

**struct** CheckoutView: View {

@ObservedObject **var** order: Order

**var** body: **some** View {

Text("Hello, World!")

}

}

For the Address, we need to add 4 new properties to Order class:

// Address properties

@Published **var** name = ""

@Published **var** streetAddress = ""

@Published **var** city = ""

@Published **var** zip = ""

Now, the AddressView will have the following structure:

**struct** AddressView: View {

@ObservedObject **var** order: Order

**var** body: **some** View {

Form {

Section {

TextField("Name", text: $order.name)

TextField("Street Address", text: $order.streetAddress)

TextField("City", text: $order.city)

TextField("Zip", text: $order.zip)

}

Section {

NavigationLink {

CheckoutView(order: order)

} label: {

Text("Check out")

}

}

}

.navigationTitle("Delivery details")

.navigationBarTitleDisplayMode(.inline)

}

}

Now there are 3 views sharing the same data. The data is not lost even when you go to the third screen and go back to the first one. this is the natural side effect of using a class for our data, but it’s an instant feature in our app without having to do any work.

Now, we will add some validations.

In the Order class, add this property at the end:

// Validation property for Address

**var** hasValidAddress: Bool {

**if** name.isEmpty || streetAddress.isEmpty || city.isEmpty ||

zip.isEmpty {

**return** **false**

}

**return** **true**

}

We can now use that condition in conjunction with SwiftUI’s disabled() modifier. For the project, we can use it after the second section in the AddressView:

Section {

NavigationLink {

CheckoutView(order: order)

} label: {

Text("Check out")

}

}

.**disabled**(order.hasValidAddress == false)

Now if you run the app you’ll see that all four address fields must contain at least one character in order to continue. Even better, SwiftUI automatically grays out the button when the condition isn’t true, giving the user really clear feedback when it is and isn’t interactive.

## Preparing for checkout - Project

The first part is to build the CheckoutView.

First, in the Order class we will add a computed property called cost that will use the following logic for the price:

* There’s a base cost of $2 per cupcake.
* We’ll add a little to the cost for more complicated cakes.
* Extra frosting will cost $1 per cake.
* Adding sprinkles will be another 50 cents per cake.

This is represented in the following code in the Order class:

**var** cost: Double {

// $2 per cacke

**var** cost = Double(quantity) \* 2

// complicated cakes cost more

cost += (Double(type) / 2)

// $1/cake for extra frosting

**if** extraFrosting {

cost += Double(quantity)

}

// $0.50/cake for sprinkles

**if** addSprinkles {

cost += Double(quantity) / 2

}

**return** cost

}

For the CheckoutView we use a ScrollView with a Vstack, and inside this, we add a AsyncImage with a scale of 3x and a specific height of 233.

We also add a text for the total and a button to place the order.

**struct** CheckoutView: View {

@ObservedObject **var** order: Order

**var** body: **some** View {

ScrollView {

VStack {

AsyncImage(url: URL(string: "https://hws.dev/img/cupcakes@3x.jpg"),

scale: 3) { image **in**

image

.resizable()

.scaledToFit()

} placeholder: {

ProgressView()

}

.frame(height: 233)

Text("Your total is \(order.cost, format: .currency(code: "USD"))")

.font(.title)

Button("Place Order", action: {})

.padding()

}

}

.navigationTitle("Check out")

.navigationBarTitleDisplayMode(.inline)

}

}

## Encoding an ObservableObject class - Project

In this project we have used one Order object that is shared between all the screens, however there is a problem, we have used the @Published property wrapper and with this, we have lost support for automatic Codable conformance.

When you try to conforme Codable in the Order class, it will fail, so now you need to do manually. Swift doesn’t understand how to encode and decode published properties and we need Codable protocol to encode and decode JSON.

First, we add an enum that conforms CodingKeys, listing all the properties we want to save.

Then, we write an encode(to:) method that creates a container using the coding keys and writes out all the properties attached to their respective keys.

Because that method is marked with **throws**, we don’t need to worry about catching any of the errors that are thrown inside – we can just use **try** without adding **catch**, knowing that any problems will automatically propagate upwards and be handled elsewhere.

Our final step is to implement a required initializer to decode an instance of **Order** from some archived data. This is pretty much the reverse of encoding, and even benefits from the same **throws** functionality

The problem *now* is that we just created a custom initializer for our **Order** class, **init(from:)**, and Swift wants us to use it everywhere , so we can create another initializar, this time empty:

**class** Order: ObservableObject, Codable {

// Add a CodingKeys enum to declare the properties we want to encode and decode

**enum** CodingKeys: CodingKey {

**case** type, quantity, extraFrosting, addSprinkles, name, streetAddress, city, zip

}

**static** **let** types = ["Vanilla", "Strawberry", "Chocolate", "Rainbow"]

@Published **var** type = 0

@Published **var** quantity = 3

@Published **var** specialRequestEnabled = **false** {

**didSet** {

**if** specialRequestEnabled == **false** {

extraFrosting = **false**

addSprinkles = **false**

}

}

}

@Published **var** extraFrosting = **false**

@Published **var** addSprinkles = **false**

// Address properties

@Published **var** name = ""

@Published **var** streetAddress = ""

@Published **var** city = ""

@Published **var** zip = ""

// Validation property for Address

**var** hasValidAddress: Bool {

**if** name.isEmpty || streetAddress.isEmpty || city.isEmpty ||

zip.isEmpty {

**return** **false**

}

**return** **true**

}

**var** cost: Double {

// $2 per cacke

**var** cost = Double(quantity) \* 2

// complicated cakes cost more

cost += (Double(type) / 2)

// $1/cake for extra frosting

**if** extraFrosting {

cost += Double(quantity)

}

// $0.50/cake for sprinkles

**if** addSprinkles {

cost += Double(quantity) / 2

}

**return** cost

}

**init**() { }

**func** encode(to encoder: Encoder) **throws** {

**var** container = encoder.container(keyedBy: CodingKeys.**self**)

**try** container.encode(type, forKey: .type)

**try** container.encode(quantity, forKey: .quantity)

**try** container.encode(extraFrosting, forKey: .extraFrosting)

**try** container.encode(addSprinkles, forKey: .addSprinkles)

**try** container.encode(name, forKey: .name)

**try** container.encode(streetAddress, forKey: .streetAddress)

**try** container.encode(city, forKey: .city)

**try** container.encode(zip, forKey: .zip)

}

**required** **init**(from decoder: Decoder) **throws** {

**let** container = **try** decoder.container(keyedBy: CodingKeys.**self**)

type = **try** container.decode(Int.**self**, forKey: .type)

quantity = **try** container.decode(Int.**self**, forKey: .quantity)

extraFrosting = **try** container.decode(Bool.**self**, forKey: .extraFrosting)

addSprinkles = **try** container.decode(Bool.**self**, forKey: .addSprinkles)

name = **try** container.decode(String.**self**, forKey: .name)

streetAddress = **try** container.decode(String.**self**, forKey: .streetAddress)

city = **try** container.decode(String.**self**, forKey: .city)

zip = **try** container.decode(String.**self**, forKey: .zip)

}

}

## Sending and receiving orders over the internet - Project

iOS comes with fantastic functionality for handling networking: the URLSession to send and receive data class combined with Codable to convert objects to and from JSON, and the URLRequest struct t configure how data should be sent.

If we have an async function like this one:

**func** placeOrder() **async** {

}

And we try to call it from a buttion like this:

Button("Place Order", action: {

placeOrder()

})

.padding()

It won’t work, because the button expects to be able to run its action immediately, and doesn’t understand how to wait for something, even with the await placeOrder() code.

We can create a new task and just like the task() modifier, this will run any kind of asyncrhonous code. We just need to add the await cal inside the Task like this:

Button("Place Order", action: {

Task {

**await** placeOrder()

}

})

.padding()

Inside **placeOrder()** we need to do three things:

1. Convert our current **order** object into some JSON data that can be sent.

2. Tell Swift how to send that data over a network call.

3. Run that request and process the response.

For the URLRequest, we need to attach the data in a very specific way, which means we need to provide 2 extra pieces of data:

1. The HTTP method of a request determines how data should be sent. There are several HTTP methods, but in practice only GET (“I want to read data”) and POST (“I want to write data”) are used much. We want to write data here, so we’ll be using POST.
2. The content type of a request determines what kind of data is being sent, which affects the way the server treats our data. This is specified in what’s called a MIME type, which was originally made for sending attachments in emails, and it has several thousand highly specific options.

The complete code of CheckoutView is this:

**struct** CheckoutView: View {

@ObservedObject **var** order: Order

@State **private** **var** confirmationMessage = ""

@State **private** **var** showingConfirmation = **false**

**var** body: **some** View {

ScrollView {

VStack {

AsyncImage(url: URL(string: "https://hws.dev/img/cupcakes@3x.jpg"),

scale: 3) { image **in**

image

.resizable()

.scaledToFit()

} placeholder: {

ProgressView()

}

.frame(height: 233)

Text("Your total is \(order.cost, format: .currency(code: "USD"))")

.font(.title)

Button("Place Order", action: {

Task {

**await** placeOrder()

}

})

.padding()

}

}

.navigationTitle("Check out")

.alert("Thank you!", isPresented: $showingConfirmation){

Button("OK") { }

} message: {

Text(confirmationMessage)

}

.navigationBarTitleDisplayMode(.inline)

}

**func** placeOrder() **async** {

// 1. Convert the current order object into JSON data

**guard** **let** encoded = **try**? JSONEncoder().encode(order) **else** {

print("Failed to encode order")

**return**

}

// 2. Tell Swift how to send that data over a network call

// Define the url to send the data to

// Force unwrap for the URL

**let** url = URL(string: "https://reqres.in/api/cupcakes")!

// Define the request

**var** request = URLRequest(url: url)

request.setValue("application/json", forHTTPHeaderField:

"Content-Type")

request.httpMethod = "POST"

**do** {

// Do the network call

**let** (data, \_) = **try** **await** URLSession.shared.upload(for: request, from: encoded)

// Decode the data from the result

**let** decodedOrder = **try** JSONDecoder().decode(Order.**self**, from:

data)

// Set up the confirmation message

confirmationMessage = "Your order for \(decodedOrder.quantity) x \(Order.types[decodedOrder.type].lowercased()) cupcakes is on its way!"

showingConfirmation = **true**

} **catch** {

print("Checkout failed.")

}

}

}

# Project 11 - Bookworm

## Creating a custom component with @Binding

You’ve already seen how SwiftUI’s **@State** property wrapper lets us work with local value types, and how **@StateObject** lets us work with shareable reference types. Well, there’s a third option, called **@Binding**, which lets us connect an **@State** property of one view to some underlying model data.

@**Binding** it lets us store a mutable value in a view that actually points to some other value from elsewhere. This is extremely important whenever you want to create a custom user interface component.

Example:

struct PushButton: View {

let title: String

**@Binding var isOn: Bool**

var onColors = [Color.red, Color.yellow]

var offColors = [Color(white: 0.6), Color(white: 0.4)]

var body: some View {

Button(title){

**isOn**.toggle()

}

.padding()

.background(

LinearGradient(

gradient: Gradient(colors: **isOn** ? onColors : offColors),

startPoint: .top,

endPoint: .bottom)

)

.foregroundColor(.white)

.clipShape(Capsule())

.shadow(radius: **isOn** ? 0 : 5)

}

}

struct ContentView: View {

@State private var rememberMe = false

var body: some View {

VStack {

***PushButton(title: "Remember Me", isOn: $rememberMe)***

Text(rememberMe ? "On" : "Off")

}

.padding()

}

}

ContentView has the rememberMe boolean, used to create the PushButton – the button has an initial value provided by ContentView. Once the button was created it takes over control of the value: it toggles the isOn property between true or false internally to the button, but to pass that change back on to the ContentView you need the property to use Binding.

Binding allows us to create a two-way connection between PushButton and whatever is using it, so when one value changes the other does too.

To use Binding, you need a property with @Binding and to add the $ to the value you use for this property (isOn in the example)

## Accepting multi-line text input with TextEditor

For long pieces ot text you should switch the TextField to use a TextEditor. It also expects to be given a two-way binding to a text string, but it has the additional benefit of allowing multiple lines of text.

Mostly because it has nothing special in the way of configuration options, using **TextEditor** is actually easier than using **TextField** – you can’t adjust its style or add placeholder text, you just bind it to a string. However, you *do* need to be careful to make sure it doesn’t go outside the safe area, otherwise typing will be tricky; embed it in a **NavigationView**, a **Form**, or similar.

struct TextEditor\_Example: View {

@AppStorage("notes") private var notes = ""

var body: some View {

NavigationView {

TextEditor(text: $notes)

.navigationTitle("Notes")

.padding()

}

}

}

Tip: @AppStorage is not designed to store secure information, so never use it for anything private.

## How to combine Core Data and SwiftUI

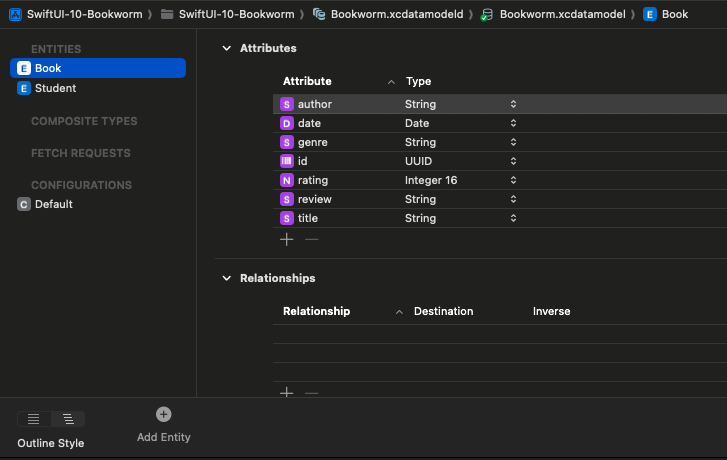
Core Data is an object graph and persistence framework, which is a fancy way of saying it lets us define objects and properties of those objects, then lets us read and write them from permanent storage.

Core Data is capable of sorting and filtering of our data, and can work with much larger data – there’s effectively no limit to how much data it can store. Even better, Core Data implements all sorts of more advanced functionality for when you really need to lean on it: data validation, lazy loading of data, undo and redo, and much more.

To setup Core Data by hand, it takes 3 steps:

* + 1. Define the data we want to use in the app. This is done in a Data Model, a file with extension “xcdatamodeld”.

To create one: press Cmd+N to make a new file, select Data Model from the list of templates, then name your model Bookworm.xcdatamodeld. When it is created, you open it and add an Entity and rename it. Next, click on the + button below the attributes and add the attributes.



* + 1. Set up Core Data. Write a little Swift code to load that model and prepare it for us to use.

Create a Swift file called DataController.swift that conforms ObservableObject and enter this:

**import** CoreData

**class** DataController: ObservableObject {

// Core Data type responsible for loading a data model

**let** container = NSPersistentContainer(name: "Bookworm")

**init**() {

container.loadPersistentStores { description, error **in**

**if** **let** error = error {

print("Core Data failed to load: \(error.localizedDescription)")

}

}

}

}

Data models don’t contain our actual data, just the definitions of properties and attributes.

To actually load the data model we need to call **loadPersistentStores()** on our container, which tells Core Data to access our saved data according to the data model in Bookworm.xcdatamodeld.

The initializer loads our stored data immediately and if something goes wrong, it will print a message to Xcode debug log.

* + 1. Create an instance of DataController and send it into SwiftUI’s environment.

Most apps work with only one Core Data store at a time, so rather than every view trying to create their own store individually we instead create it once when our app starts, then store it inside the SwiftUI environment so everywhere else in our app can use it.

In the BookworkApp.swift add this:

**import** SwiftUI

**@main**

**struct** SwiftUI\_10\_BookwormApp: App {

// Creates the data controller

@StateObject **private** **var** dataController = DataController()

**var** body: **some** Scene {

WindowGroup {

ContentView()

.environment(\.managedObjectContext,

dataController.container.viewContext)

}

}

}

The managed object context are the “live” version of your data, when you load objects and change them, those changes only exist in memory until you specifically save them back to persistent store.

The job of the view context is to let us work with all our data in memory, which is much faster than constantly reading and writing data to disk.

Now we need to read and write data.

Retrieving information from Core Data is done using a *fetch request* – we describe what we want, how it should sorted, and whether any filters should be used, and Core Data sends back all the matching data. We need to make sure that this fetch request stays up to date.

For that we use a property wrapper called @FetchRequest and it takes at least one parameter describing how we want the result to be sorted.

In the ContentView add this:

@FetchRequest(sortDescriptors: [

SortDescriptor(\.title),

SortDescriptor(\.author, order: .reverse)

]) **var** books: FetchedResults<Book>

When we defined the entity Core Data created a class for us that inherits from one of its own classes: **NSManagedObject**. This one cannot be seen in our code. These objects are called *managed* because Core Data is looking after them.

All our managed objects live inside a *managed object context*, one of which we created earlier. Placing it into the SwiftUI environment meant that it was automatically used for the **@FetchRequest** property wrapper

when it comes to adding and saving objects, we need access to the managed object context that it is in SwiftUI’s environment. add this property to **ContentView** now

@Environment(\.managedObjectContext) **var** moc

To ask our managed object context to save itself, means it will write its changes to the persistent store. This is a throwing function call, because in theory it might fail. In practice, nothing about what we’ve done has any chance of failing, so we can call this using **try?** – we don’t care about catching errors.

try? moc.save()

## Creating books with Core Data

# Project 12 – Core Data

This technique project is going to explore Core Data in more detail, starting with a summary of some basic techniques then building up to tackling some more complex problems.

## Why does .self work for ForEach?

Previously we looked at the various ways **ForEach** can be used to create dynamic views, but they all had one thing in common: SwiftUI needs to know how to identify each dynamic view uniquely so that it can animate changes correctly.

There are several ways, like the object conforming the Identifiable protocol and use the id property, or use a keypath for a property that we know is unique and also using the \.selft.

Example:

List {

ForEach([2, 4, 6, 8, 10], id: \.self) {

Text("\($0) is even")

}

}

When we use **\.self** as an identifier, we mean “the whole object”, but in practice that doesn’t mean much. So what actually happens is that Swift computes the *hash value* of the struct, which is a way of representing complex data in fixed-size values, then uses that hash as an identifier.

Hash values can be generated in any number of ways, but the concept is identical for all hash- generating functions:

1. Regardless of the input size, the output should be the same fixed size.

2. Calculating the same hash for an object twice in a row should return the same value.

Hashes are commonly used for things like data verification.

Xcode generates a class for our managed objects, it makes that class conform to **Hashable**, which is a protocol that means Swift can generate hash values for it, which in turn means we can use **\.self** for the identifier. This is also why **String** and **Int** work with **\.self**: they also conform to **Hashable**.

**Hashable** is a bit like **Codable**: if we want to make a custom type conform to **Hashable**, then as long as everything it contains also conforms to **Hashable** then we don’t need to do any work.

**struct** Student: Hashable {

**let** name: String

}

**struct** \_1\_HashableExample: View {

**let** students = [Student(name: "Harry Potter"), Student(name: "Louse Lane")]

**var** body: **some** View {

List(students, id: \.**self**) { student **in**

Text(student.name)

}

}

}

We can make **Student** conform to **Hashable** because all its properties already conform to **Hashable**, so Swift will calculate the hash values of each property then combine them into one hash that represents the whole struct. Of course, if we end up with two students that have the same name we’ll hit problems.

When using Core Data, the objects it creates for us actually have a selection of other properties beyond those we defined in our data model, including one called the object ID. These IDs are similar to **UUID**, although Core Data generates them sequentially as we create objects.

So \.self works for Core Data’s objects because they already conform to Hashable. So, if you want to use a specific identifier that’s awesome, but you don’t need to because **\.self** is also an option.

**Warning:** Although calculating the same hash for an object twice in a row should return the same value, calculating it between two runs of your app – i.e., calculating the hash, quitting the app, relaunching, then calculating the hash again – can return different values.

## Creating NSManagedObject subclasses

When we create a new Core Data entity, Xcode automatically generates a managed object class for us when we build our code. We can then use that in a SwiftUI **@FetchRequest** to show data in our user interface, but it is a quite painful because there are lots of optionals to unwrap.

There are 2 solutions. First, we can create an entity to work with: open your data model and create an entity with some attributes. In the View mene, choose Inspectors> Show Data Model Inspector and if you choose the entity, you can see a property called Codegen. This controls how Xcode generates the entity as a managed object class when we build our project. For that property, select Manual/None. With this value, Xcode will no longer generate the entity class for you to use in code.

Then you need to go to the Editor menu and choose Create NSManagedObject Subclass, make sure “CoreDataProject” is selected then press Next, then make sure your entity is selected and press Next again. Xcode will convert its generated code into actual Swift files that we can see and change, but keep in mind if you change the files Xcode generated and you re-generate those files, your changes will be lost.

Xcode will have generated two files for us, but we only care about one of them: Movie+CoreDataProperties.swift. You will something like this example:

extension Movie {

@nonobjc public class func fetchRequest() -> NSFetchRequest<Movie> {

return NSFetchRequest<Movie>(entityName: "Movie")

}

@NSManaged public var title: String?

@NSManaged public var director: String?

@NSManaged public var year: Int16

}

extension Movie : Identifiable {

}

Here is where the optional is set for the properties which use @NSManaged for all of them. **@NSManaged** is *not* a property wrapper. When we read or write the value of a property that is **@NSManaged**, Core Data catches that and handles it internally. However changing this class, like removing the optional (?) from the properties might not work because Core Data is lazy.

Instead of removing the optional, you might want to consider add computed properties to access optional values safely, while also letting us store your nil coalescing code all in one place:

public var wrappedTitle: String {

title ?? "Unknown Title"

}

## Conditional saving of NSManagedObjectContext

We’ve been using the **save()** method of **NSManagedObjectContext** to flush out all unsaved changes to permanent storage, but there is a way to check wheter any changes actually need to be saved.

Every managed object is given a **hasChanges** property, that is true when the object has unsaved changes. And, the entire context also contains a **hasChanges** property that checks whether any object owned by the context has changes.

So, rather than call **save()** directly you should always wrap it in a check first, like this:

if moc.hasChanges {

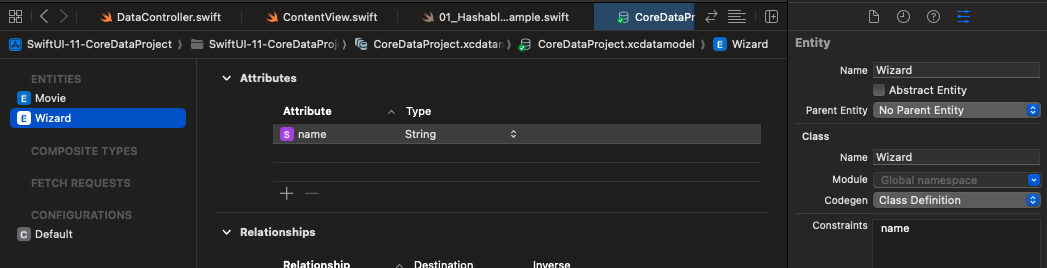
try? moc.save()

}

## Ensuring Core Data objects are unique using constraints

Core Data gives us *constraints*: we can make one attribute constrained so that it must always be unique. We can then go ahead and make as many objects as we want, unique or otherwise, but as soon as we ask Core Data to save those objects it will resolve duplicates so that only one piece of data gets written. Even better, if there was some data already written that clashes with our constraint, we can choose how it should handle merging the data.

For example, for a specif entity, you can go to View > Inspectors > Data Model, in the right panel, you will see a Constraints section where you can add a new element. If you add a new one and change it to use the name of a specific entity’s property, like in this example:



If you have a code like the following, when you can add a new Wizard element to a list with the same name (which is the field used as a constraint, or in other words, it must be unique), you can add all the elements you want, but as soon as you hit the Save button, you will receive an error, Core Data has detected the collision and is refusing to save the changes:

**struct** \_\_ConstraintExample: View {

@Environment(\.managedObjectContext) **var** moc

@FetchRequest(sortDescriptors: []) **var** wizards: FetchedResults<Wizard>

**var** body: **some** View {

VStack{

List(wizards, id: \.**self**) { wizard **in**

Text(wizard.name ?? "Unknown")

}

Button("Add") {

**let** wizard = Wizard(context: moc)

wizard.name = "Harry Potter"

}

Button("Save") {

**do** {

**try** moc.save()

} **catch** {

print(error.localizedDescription)

}

}

}

}

}

If you *want* Core Data to write the changes, you need to open DataController.swift and adjust the loadPersistentStores() completion handler to specify how data should be merged in this situation:

container.loadPersistentStores { description, error in

if let error = error {

print("Core Data failed to load: \(error.localizedDescription)")

return

}

self.container.viewContext.mergePolicy = NSMergePolicy.mergeByPropertyObjectTrump

}

That asks Core Data to merge duplicate objects based on their properties.

## Filtering @FetchRequest using NSPredicate

When we use SwiftUI’s **@FetchRequest** property wrapper, we can provide an array of sort descriptors to control the ordering of results, but we can also provide an **NSPredicate** to control *which* results should be shown.

In the following example, we have an Entity called Ship with two string attibutes (name and universe) and we have the following code:

**struct** \_3\_NSPredicateExample: View {

@Environment(\.managedObjectContext) **var** moc

@FetchRequest(sortDescriptors: [], predicate:

NSPredicate(format: "universe == %@", "Star Wars")

) **var** ships: FetchedResults<Ship>

**var** body: **some** View {

VStack {

List(ships, id: \.**self**) { ship **in**

Text(ship.name ?? "Unknown name")

}

}

Button("Add Examples"){

**let** ship1 = Ship(context: moc)

ship1.name = "Enterprise"

ship1.universe = "Star Trek"

**let** ship2 = Ship(context: moc)

ship2.name = "Defiant"

ship2.universe = "Star Trek"

**let** ship3 = Ship(context: moc)

ship3.name = "Millennium Falcon"

ship3.universe = "Star Wars"

**let** ship4 = Ship(context: moc)

ship4.name = "Executor"

ship4.universe = "Star Wars"

**try**? moc.save()

}

}

}

The predicate we have it is basically asking to show only the ships which universe is Star Wars, the %@ is used to indicate a value will be provided, in this case, ‘Star Wars’.

As well as **==**, we can also use comparisons such as **<** and **>** to filter our objects. For example

this will return Defiant, Enterprise, and Executor:

NSPredicate(format: "name < %@", "F"))

We could use an **IN** predicate to check whether the universe is one of three options from an array, like this:

NSPredicate(format: "universe IN %@", ["Aliens", "Firefly","Star Trek"])

We can also use predicates to examine part of a string, using operators such as **BEGINSWITH** and **CONTAINS**. For example,

NSPredicate(format: "name BEGINSWITH %@", "E"))

You can flip predicates around using **NOT**, to get the inverse of their regular behavior

NSPredicate(format: "NOT name BEGINSWITH[c] %@", "e"))

## Dynamically filtering @FetchRequest with SwiftUI

Fetch requests are created as a property, so if you try to make them reference another property Swift will refuse. To solve this, we should carve off the functionality we want into a separate view, then inject values into it.

As an example, we have the following SwitfUI view

**struct** \_4\_DynamicFiltering: View {

@Environment(\.managedObjectContext) **var** moc

@State **private** **var** lastNameFilter = "T"

**var** body: **some** View {

VStack {

// list of matching singers

\_4\_FilteredList(filter: lastNameFilter)

}

Button("Add Examples"){

**let** bjorn = Singer(context: moc)

bjorn.firstName = "Bjorn"

bjorn.lastName = "Speed"

**let** wayne = Singer(context: moc)

wayne.firstName = "Wayne"

wayne.lastName = "Static"

**let** corey = Singer(context: moc)

corey.firstName = "Corey"

corey.lastName = "Taylor"

**try**? moc.save()

}

Button("Show T" ){

lastNameFilter = "T"

}

Button("Show S" ){

lastNameFilter = "S"

}

}

}

}

The previous UI class has a property called lastNameFilter with a default value, that can be changed dynamically and it is used to called another SwiftUI that will receive that value to load a list of elements, in this case, a list of Singer elements, but applying the filter in the initialization of the UI.

**struct** \_4\_FilteredList: View {

@FetchRequest **var** fetchRequest: FetchedResults<Singer>

**var** body: **some** View {

List(fetchRequest, id: \.**self**){ singer **in**

Text("\(singer.wrappedFirstName) \(singer.wrappedLastName)")

}

}

**init**(filter: String) {

// Initialize the view with a fetch request with a predicate that uses the filter

// by using the \_ we are requesting new results to load

\_fetchRequest = FetchRequest<Singer>(sortDescriptors: [], predicate: NSPredicate(format: "lastName BEGINSWITH %@", filter))

}

}

The FilterList view is the one using the FetchRequest. That will run a fetch request using the current managed object context. Because this view will be used inside **ContentView**, we don’t even need to inject a managed object context into the environment.

The reason for the underscore in the \_fetchRequest is beause you are not writing to the fetched object inside the fetch request, but instead writing a wholly new fetch request.

You might look at our code and think that every time the view is recreated – which is every time any state changes in our container view – we’re also recreating the fetch request, which in turn means reading from the database when nothing else has changed. But Core Data won’t do that, it will only re-run the database query when the filter string changes, even if the view is recreated.

For a more flexible FilteredList, we can work with generics:

1. Rather than specifically referencing the **Singer** class, we’re going to use generics with a constraint that whatever is passed in must be an **NSManagedObject**.

2. We need to accept a second parameter to decide which key name we want to filter on, because we might be using an entity that doesn’t have a **lastName** attribute.

3. Because we don’t know ahead of time what each entity will contain, we’re going to let our containing view decide. So, rather than just using a text view of a singer’s name, we’re instead going to ask for a closure that can be run to configure the view however they wan

The FilteredList will look like this:

**import** CoreData

**import** SwiftUI

**struct** \_4\_FilteredList<T: NSManagedObject, Content: View>: View {

@FetchRequest **var** fetchRequest: FetchedResults<T>

// Accept whatever T represents and return some Content

**let** content: (T) -> Content

**var** body: **some** View {

List(fetchRequest, id: \.**self**){ item **in**

**self**.content(item)

}

}

**init**(filterKey: String, filterValue: String, @ViewBuilder content: **@escaping** (T) -> Content) {

// Initialize the view with a fetch request with a predicate that uses the filter

// by using the \_ we are requesting new results to load

\_fetchRequest = FetchRequest<T>(sortDescriptors: [], predicate: NSPredicate(format: "&K BEGINSWITH %@", filterKey, filterValue))

**self**.content = content

}

}

Some important things here:

* The View now receives a generic type (T) and a Swift UI view as Content.
* The content is the closure, this will be called once for each item in the list.
* For the predicate, when we use %@, Core Data automatically inserts quote marks for us, so for the filterKey it doesn’t work, instead we need to use %K for “key”.

For the closure that decides the content of each list row we need to use:

**• @ViewBuilder** lets our containing view (whatever is using the list) send in multiple views if they want.

**• @escaping** says the closure will be stored away and used later, which means Swift needs to take care of its memory.

Now, in the ContentView that calls the FilteredList we can have:

\_4\_FilteredList(filterKey: "lastName", filterValue: lastNameFilter){ (singer: Singer) **in**

Text("\(singer.wrappedFirstName) \(singer.wrappedLastName)")

}

The (singer: Singer) is required so that Swift understands how FilteredList is being used, to make Swfit understand what exactly type of managed object we are using.

## One-to-many relationships with Core Data, SwiftUI, and @FetchRequest

Core Data allows us to link entities together using relationships, and when we use **@FetchRequest** Core Data sends all that data back to us for use. However we need to make a custom NSManagedObject subclass.

In the example, we will use 2 Core Data entities: one to track candy bars and one to track countries where those bars come from.

Relationships come in four forms:

• A one to one relationship means that one object in an entity links to exactly one object in another entity.

• A one to many relationship means that one object in an entity links to many objects in another entity. In our example, this would mean that one type of candy could have been introduced simultaneously in many countries, but that each country still could only make one type of candy.

• A many to one relationship means that many objects in an entity link to one object in another entity. In our example, this would mean that each type of candy has one country of origin, and that each country can make many types of candy.

• A many to many relationship means that many objects in an entity link to many objects in another entity. In our example, this would mean that one type of candy had been introduced simultaneously in many countries, and each country can make many types of candy.

In the example, we will work with one to many relationship. We add a Candy entity with a name attribute and a Country entity with fullName and shortName attributes.

To add a relationship between entityes, select one, start with Country and press + under Relationships table. Call the relationship “candy”, change its destination to Candy, then over in the data model inspector change Type to To Many.

Now select Candy, and add another relationship there. Call the relationship “origin”, change its destination to “Country”, then set its inverse to “candy” so Core Data understands the link goes both ways.

Press Cmd+S to force Xcode to save the changes and generate the code for us. Select both Candy and Country and set their Codegen to Manual/None, then go to the Editor menu and choose Create NSManagedObject Subclass to create code for both our entities – remember to save them in the CoreDataProject group and folder.

In the Country+CoreDataProperties we have a candy property that is a NSSet (Objective-C data type for Set). To fix this we need to modify the files Xcode generated for us, adding convenience wrappers that make SwiftUI work well.

For the candy wrapper, we need first to convert it from NSSet to a Set<Candy> and then convert that Set<Candy> into an array, so that ForEach can read individual values from there and then sort the values.

That class would look like this:

extension Country {

    @nonobjc public class func fetchRequest() -> NSFetchRequest<Country> {

        return NSFetchRequest<Country>(entityName: "Country")

    }

    @NSManaged public var fullName: String?

    @NSManaged public var shortName: String?

    @NSManaged public var candy: NSSet?

    public var wrappedShortName: String {

        shortName ?? "Unknown Country"

    }

    public var wrappedFullName: String {

        fullName ?? "Unknown Country"

    }

    public var candyArry: [Candy] {

        // Try to convert a NSSet to a Set of Candy

        let set = candy as? Set<Candy> ?? []

        return set.sorted {

            $0.wrappedName < $1.wrappedName

        }

    }

}

As we have a custom type, we cannot just use sorted(), instead we have to provide a closure that accepts two candy bars and returns true if the frist candy should be sorted before the second.

In the corresponding view, add the following code:

struct \_5\_RelationshipsExample: View {

@Environment(\.managedObjectContext) var moc

@FetchRequest(sortDescriptors: []) var countries: FetchedResults<Country>

var body: some View {

VStack {

List {

ForEach(countries, id: \.self) { country in

Section(country.wrappedFullName) {

ForEach(country.candyArry, id: \.self) { candy in

Text(candy.wrappedName)

}

}

}

}

Button("Add Examples") {

let candy1 = Candy(context: moc)

candy1.name = "Mars"

candy1.origin = Country(context: moc)

candy1.origin?.shortName = "UK"

candy1.origin?.fullName = "United Kingdom"

let candy2 = Candy(context: moc)

candy2.name = "KitKat"

candy2.origin = Country(context: moc)

candy2.origin?.shortName = "UK"

candy2.origin?.fullName = "United Kingdom"

let candy3 = Candy(context: moc)

candy3.name = "Toblerone"

candy3.origin = Country(context: moc)

candy3.origin?.shortName = "CH"

candy3.origin?.fullName = "Switzerland"

let candy4 = Candy(context: moc)

candy4.name = "Tapita Gallito"

candy4.origin = Country(context: moc)

candy4.origin?.shortName = "CRC"

candy4.origin?.fullName = "Costa Rica"

try? moc.save()

}

}

}

}

Notice how we don’t need to specify anything about the relationships in our fetch request – Core Data understands the entities are linked, so it will just fetch them all as needed.

# Project 13 - Instafilter

The next app will allow the user to import photos from their library, and modify them, using Apple's Core Image framework integrating with UIKit.

## How Propery Wrappers Become Structs

You’ve seen how SwiftUI lets us store changing data in our structs by using the @State property wrapper, how we can bind that state to the value of a UI control using $, and how changes to that state automatically cause SwiftUI to reinvoke the body property of our struct

Property wrappers have that name because they wrap our property inside another struct. What this means is that when we use @State to wrap a string, the actual type of property we end up with is a State<String>. Similarly, when we use @Environment and others we end up with a struct of type Environment that contains some other value inside it.

We know properties cannot be modified in our views because they are structs and therefore, they are fixed.

Note: Cmd+Shift+O lets you to open the Open Quickly to look for ay file or type in the project or frameworks you have imported.

In the following example:

struct \_1\_PropWrapperExe: View {

@State private var blurAmount = 0.0 {

didSet {

print("New value is \(blurAmount)")

}

}

var body: some View {

VStack{

Text("Hello world!")

.blur(radius: blurAmount)

Slider(value: $blurAmount, in: 0...20)

Button("Random Blur") {

blurAmount = Double.random(in: 0...20)

}

}

}

}

You will see that when the value of the blurAmount is changed, we don't see the text printed as expected, except when you press the button. This happens because @State actually wraps its contents, what it’s actually saying is that when the State

struct that wraps blurAmount changes, print out the new blur amount.

You’ve just seen how State wraps its value using a non-mutating setter, which means neither blurAmount or the State struct wrapping it are changing – our binding is directly changing the internally stored value, which means the property observer is never being triggered.

So, changing the property directly using a button works fine, because it goes through the nonmutating setter and triggers the didSet observer, but using a binding doesn’t because it bypasses the setter and adjusts the value directly.

## Responding to state changes using onChange()

Because of the way SwiftUI sends binding updates to property wrappers, assigning property observers used with property wrappers often won’t work.

To fix this we need to use the onChange() modifier, which tells SwiftUI to run a function of our choosing when a particular value changes. SwiftUI will automatically pass in the new value to whatever function you attach, or you can just read the original property if you prefer:

struct \_1\_PropWrapperExe: View {

@State private var blurAmount = 0.0

var body: some View {

VStack{

Text("Hello world!")

.blur(radius: blurAmount)

Slider(value: $blurAmount, in: 0...20)

.onChange(of: blurAmount) { newValue in

print("New value is \(newValue)")

}

Button("Random Blur") {

blurAmount = Double.random(in: 0...20)

}

}

}

}

you can do whatever you want inside the onChange() function: you can call methods, run an algorithm to figure out how to apply the change, or whatever else you might need.

## Showing multiple options with confirmationDialog()

SwiftUI gives us alert() for presenting important announcements with one or two buttons, and sheet() for presenting whole views on top of the current view, but it also gives us confirmationDialog(): an alternative to alert() that lets us add many buttons.

The following is an example of the confirmationDialog:

struct \_2\_MultipleOptsExe: View {

@State private var showingConfirmation = false

@State private var backgroundColor = Color.white

var body: some View {

Text("Hello, World!")

.frame(width: 300, height: 300)

.background(backgroundColor)

.onTapGesture {

showingConfirmation = true

}

.confirmationDialog("Change background", isPresented: $showingConfirmation){

Button("Red") { backgroundColor = .red}

Button("Green") { backgroundColor = .green }

Button("Blue") { backgroundColor = .blue }

Button("Cancel", role: .cancel){ }

} message: {

Text("Select a new color")

}

}

}

As with the alert message, this is a modifier for the text and it accepts two parameters: a binding that decides whether the dialog is currently presented or not and a closure that provides the buttons that should be shown.

## Integrating Core Image with SwiftUI

Just like Core Data is Apple’s built-in framework for manipulating data, Core Image is their framework for manipulating images. Core Image doesn’t integrate into SwiftUI very well, however there are some useful helpers to make it work.

Having the following example:

**struct** \_3\_CoreImageExe: View {

@State **private** **var** image: Image?

**var** body: **some** View {

VStack {

image?

.resizable()

.scaledToFit()

}

.onAppear(perform: loadImage)

}

**func** loadImage() {

image = Image("example")

}

}

The onAppear is attached to the VStack because if the optional image is nil the it won’t trigger the onAppear function

If we want to use Core Image, SwiftUI’s **Image** view is a great end point, but it’s not useful to use elsewhere. That is, if we want to create images dynamically, apply Core Image filters, save them to the user’s photo library, and so on, then SwiftUI’s images aren’t up to the job.

Apple gives us three other image types to work with, and cunningly we need to use all three if we want to work with Core Image.

Apart from SwiftUI’s **Image** view, the three other image types are:

* **UIImage**, which comes from UIKit. This is an extremely powerful image type capable of working with a variety of image types, including bitmaps (like PNG), vectors (like SVG), and even sequences that form an animation. **UIImage** is the standard image type for UIKit, and of the three it’s closest to SwiftUI’s **Image** type.
* **CGImage**, which comes from Core Graphics. This is a simpler image type that is really just a two-dimensional array of pixels.
* **CIImage**, which comes from Core Image. This stores all the information required to produce an image but doesn’t actually turn that into pixels unless it’s asked to. Apple calls **CIImage** “an image recipe” rather than an actual image.

There is some interoperability between the various image types:

* We can create a **UIImage** from a **CGImage**, and create a **CGImage** from a **UIImage**.
* We can create a **CIImage** from a **UIImage** and from a **CGImage**, and can create a **CGImage** from a **CIImage**.
* We can create a SwiftUI **Image** from both a **UIImage** and a **CGImage**.

In the example, we will change the loadImage method:

First, we load an image into a UIImage. Then, we convert the UIImage into a CIImage.

Then we create a core Image context and a Core Image filter. Filters are the things that do the actual work of transforming image data somehow, such as blurring it, sharpening it, adjusting the colors, and so on, and contexts handle converting that processed data into a **CGImage** we can work with.

The sepia filter has 2 properties: inputImage that is the image we want to change and intensity, that is how strongly the effect should be applied specifiend in a range of 0 to 1

Then we need to convert the output from the filter to a SwiftUI Image. The easiest thing to do is:

* Read the output image from our filter, which will be a CIImage. This might fail, so it returns an optional.
* Ask our context to create a CGImage from that output image. This also might fail, so again it returns an optional.
* Convert that CGImage into a UIImage.
* Convert that UIImage into a SwiftUI Image.

The complete example looks like this:

**import** SwiftUI

**import** CoreImage

**import** CoreImage.CIFilterBuiltins

**struct** \_3\_CoreImageExe: View {

@State **private** **var** image: Image?

**var** body: **some** View {

VStack {

image?

.resizable()

.scaledToFit()

}

.onAppear(perform: loadImage)

}

**func** loadImage() {

// Load he image into a UIImage

**guard** **let** inputImage = UIImage(named: "example") **else** { **return** }

// Convert the UIImage into a CIImage

**let** beginImage = CIImage(image: inputImage)

// Create a context

**let** context = CIContext()

// Create a filter usine sepia tone

**let** currentFilter = CIFilter.sepiaTone()

// Apply the filter

currentFilter.inputImage = beginImage

currentFilter.intensity = 1

// Get a CIImage from the filter or exit if that fails

**guard** **let** outputImage = currentFilter.outputImage **else** { **return** }

// Attempt to get a CGImage from or CIImage

**if** **let** cgimg = context.createCGImage(outputImage,

from: outputImage.extent) {

// Convert that to a UIImage

**let** uiImage = UIImage(cgImage: cgimg)

// And convert that to a SwiftUI image

image = Image(uiImage: uiImage)

}

}

}

Another example of filters are:

let currentFilter = CIFilter.pixellate()

currentFilter.inputImage = beginImage

currentFilter.scale = 100

When that runs you’ll see our image looks pixellated. A scale of 100 should mean the pixels are 100 points across

Or add a twirl distortion filter:

let currentFilter = CIFilter.twirlDistortion()

currentFilter.inputImage = beginImage

currentFilter.radius = 1000

currentFilter.center = CGPoint(x: inputImage.size.width / 2, y:

inputImage.size.height / 2)

With the older API, setting values such radius and scale can be done dynamically:

let currentFilter = CIFilter.twirlDistortion()

currentFilter.inputImage = beginImage

let amount = 1.0

let inputKeys = currentFilter.inputKeys

if inputKeys.contains(kCIInputIntensityKey) {

currentFilter.setValue(amount, forKey:kCIInputIntensityKey)

}

if inputKeys.contains(kCIInputRadiusKey){

currentFilter.setValue(amount \* 200, forKey:kCIInputRadiusKey)

}

if inputKeys.contains(kCIInputScaleKey)

{

currentFilter.setValue(amount \* 10, forKey:kCIInputScaleKey)

}

## Wrapping a UIViewController in a SwiftUI view

In this project we’re going to ask users to import a picture from their photo library. Apple’s APIs come with dedicated code for doing just this, but that hasn’t been ported to SwiftUI and so we need to write that bridge ourself. Instead, it’s built into a separate framework called PhotosUI, which was designed to work with UIKit and so requires us to look at the way UIKit works.

Before starting it is important to know this about UIKit:

1. UIKit has a class called **UIView**, which is the parent class of all views in the layouts. So, labels, buttons, text fields, sliders, and so on – those are all views.

2. UIKit has a class called **UIViewController**, which is designed to hold all the code to bring views to life. Just like **UIView**, **UIViewController** has many subclasses that do different kinds of work.

3. UIKit uses a design pattern called *delegation* to decide where work happens. So, when it came to deciding how to respond to a text field changing, we’d create a custom class with our functionality and make that the delegate of our text field.

All this matters because asking the user to select a photo from their library uses a view controller called **PHPickerViewController**, and the delegate protocol **PHPickerViewControllerDelegate**. SwiftUI can’t use these two directly, so we need to wrap them.

Conforming to **UIViewControllerRepresentable** does require us to fill in that struct with two methods: one called **makeUIViewController()**, which is responsible for creating the initial view controller, and another called **updateUIViewController()**, which is designed to let us update the view controller when some SwiftUI state changes.

The ImagePicker file wll have this:

**import** Foundation

**import** PhotosUI

**import** SwiftUI

**struct** ImagePicker: UIViewControllerRepresentable {

**typealias** UIViewControllerType = PHPickerViewController

**func** makeUIViewController(context: Context) -> PHPickerViewController {

// Creates a new photo picker configuration asking to provide only images

**var** config = PHPickerConfiguration()

config.filter = .images

**let** picker = PHPickerViewController(configuration: config)

**return** picker

}

**func** updateUIViewController(\_ uiViewController: PHPickerViewController, context: Context) {

}

}

And the SwifUI view will have this (so far):

**struct** \_4\_UIViewControllerExe: View {

@State **private** **var** image: Image?

@State **private** **var** showingImagePicker = **false**

**var** body: **some** View {

VStack {

image?

.resizable()

.scaledToFit()

Button("Select Image") {

showingImagePicker = **true**

}

}

.sheet(isPresented: $showingImagePicker) {

ImagePicker()

}

}

}

But the PHPickerViewController is not responding to interactions, for that, we need to know about coordinators.

## Using coordinators to manage SwiftUI view controllers

SwiftUI’s coordinators are nothing like the coordinator pattern many developers used with UIKit.

SwiftUI’s coordinators are designed to act as delegates for UIKit view controllers. Remember, “delegates” are objects that respond to events that occur elsewhere. For example, UIKit lets us attach a delegate object to its text field view, and that delegate will be notified when the user types anything, when they press return, and so on. This meant that UIKit developers could modify the way their text field behaved without having to create a custom text field type of their own.

We will modify the ImagePicker struct to this:

**import** Foundation

**import** PhotosUI

**import** SwiftUI

**struct** ImagePicker: UIViewControllerRepresentable {

**class** Coordinator: NSObject, PHPickerViewControllerDelegate {

**func** picker(\_ picker: PHPickerViewController, didFinishPicking results: [PHPickerResult]) {

// Tell the picker to go away

picker.dismiss(animated: **true**)

// Exit if no selection was made

**guard** **let** provider = results.first?.itemProvider **else** { **return** }

// If this has an image we can use, use it

**if** provider.canLoadObject(ofClass: UIImage.**self**) {

provider.loadObject(ofClass: UIImage.**self**) { image, \_ **in**

**self**.parent.image = image **as**? UIImage

}

}

}

**var** parent: ImagePicker

**init**(parent: ImagePicker) {

**self**.parent = parent

}

}

@Binding **var** image: UIImage?

**typealias** UIViewControllerType = PHPickerViewController

**func** makeUIViewController(context: Context) -> PHPickerViewController {

// Creates a new photo picker configuration asking to provide only images

**var** config = PHPickerConfiguration(photoLibrary: PHPhotoLibrary.shared())

config.filter = .images

**let** picker = PHPickerViewController(configuration: config)

// Tells the PHPickerViewController that when something happens it should inform the coordinator.

picker.delegate = context.coordinator

**return** picker

}

**func** updateUIViewController(\_ uiViewController: PHPickerViewController, context: Context) {

}

// SwiftUI will automatically call this method if we implement it

**func** makeCoordinator() -> Coordinator {

Coordinator(**self**)

}

}

Things that happened here:

* We added a class nested in the struct (Coordinator), that will inherit from NSObject (this allows Objective-C to ask the object what functionlity it supports at runtime, like when the user has selected an image.
* This class also conforms to the **PHPickerViewControllerDelegate** protocol, which is what adds functionality for detecting when the user selects an image. (**NSObject** lets Objective-C *check* for the functionality; this protocol is what actually provides it.)
* We assign this coordinator as a delegate for the PHPickerViewController so when something happens, this should inform the coordinator.
* The ImagePicker has now a binding property can set the binding value in our image picker and have it actually update a value being stored somewhere else.
* We tell the coordinator what its parent is, so it can modify values there directly. That is why we added the parent property and the initializer to the Coordinator class.
* The picker function inside the Coordinator class will read the response from the PHPickerViewController.

Then we have the Swift UI class, where we can now use the ImagePicker view. We add a new property inputImage. The sheet() modifier will pass that property into the image picker and it will be updated when the image is selected.

Next, we need a method we can call when that property changes. Remember, we can’t use a plain property observer here because Swift will ignore changes to the binding, so instead we’ll write a method that checks whether **inputImage** has a value, and if it does uses it to assign a new **Image** view to the **image** property. The method is loadImage

We can now use the onChange() modifier to call loadImage() whenever a new image is chosen.

**struct** \_4\_UIViewControllerExe: View {

@State **private** **var** image: Image?

@State **private** **var** showingImagePicker = **false**

@State **private** **var** inputImage: UIImage?

**var** body: **some** View {

VStack {

image?

.resizable()

.scaledToFit()

Button("Select Image") {

showingImagePicker = **true**

}

}

.sheet(isPresented: $showingImagePicker) {

ImagePicker(image: $inputImage)

}

.onChange(of: inputImage) { \_ **in** loadImage() }

}

**func** loadImage() {

**guard** **let** inputImage = inputImage **else** { **return** }

image = Image(uiImage: inputImage)

}

}

In Summary:

* We created a SwiftUI view that conforms to UIViewControllerRepresentable. • We gave it a makeUIViewController() method that created some sort of
* UIViewController, which in our example was a PHPickerViewController.
* We added a nested Coordinator class to act as a bridge between the UIKit view controller and our SwiftUI view.
* We gave that coordinator a didFinishPicking method, which will be triggered by iOS when an image was selected.
* Finally, we gave our ImagePicker an @Binding property so that it can send changes back to a parent view.

## How to save images to the user’s photo library

In this part we need to add a configuration option for the project. You need to select the project in the Project Navigation bar, then select the targets and open the Info tab.

Every project we build has a whole bunch of these baked right in, describing which interface orientations we support, the version number of our app, and other fixed pieces of data.

These options all live in a particular place in Xcode, and it’s bizarrely hard to find unless you know what you’re doing:

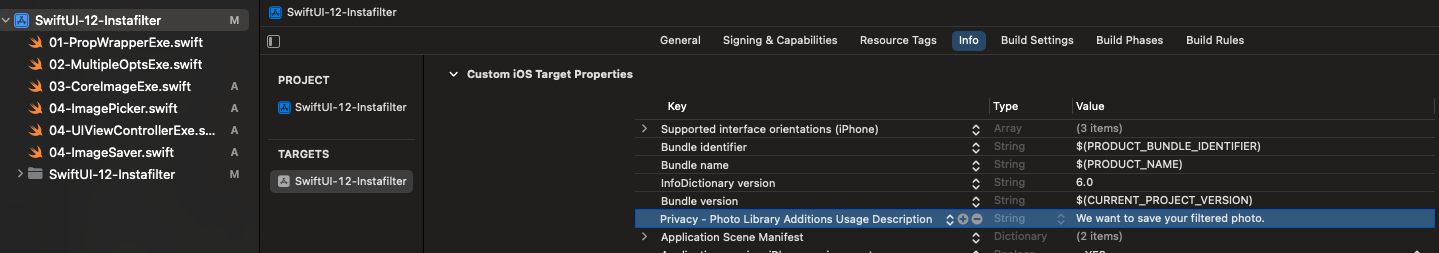
1. In the Project Navigator, select the top item in the tree. It will have your project name, Instafilter.

2. You’ll see Instafilter listed under both PROJECT and TARGETS. Please select it under TARGETS.

3. Now you’ll see a bunch of tabs across the top, including General, Signing & Capabilities, and more – select Info from there.

As writing to the photo library is a protected operation, we need to ask for permission to the user. iOS will take care of asking for permission and checking the response, but *we* need to provide a short string explaining to users why we want to write images in the first place.

To add your permission string, right-click on any of the existing options then choose Add Row. You’ll see a dropdown list of options to choose from – I’d like you to scroll down and select “Privacy - Photo Library Additions Usage Description”. For the value on its right, please enter the text “We want to save the filtered photo.”



After that, in the loadImage method we have, we can now use the **UIImageWriteToSavedPhotosAlbum()** method to write out a picture.

The first time you use it, iOS will automatically prompt the user for permission to write the photo and show the string we added to the configuration options.

The second and third parameter of this method tell Swift what method should be called when saving completes, which in turn will tell us whether the save operation succeeded or failed. This code is old, and these two parameters have their own complexities:

• The object we provide must be a class, and it must inherit from **NSObject**. This means we can’t point to a SwiftUI view struct.

• The method is provided as a method *name*, not an actual method. This method name was used by Objective-C to find the actual code at runtime, which could then be run. That method needs to have a specific signature (list of parameters) otherwise our code just won’t work.

So, we need to create a class that inherits from NSObject, Inside there we need a method with a precise signature that’s marked with **@objc**, and we can then call that from **UIImageWriteToSavedPhotosAlbum()**.

**import** UIKit

**class** ImageSaver: NSObject {

**func** writeToPhotoAlbum(image: UIImage){

UIImageWriteToSavedPhotosAlbum(image, **self**, **#selector**(saveCompleted), **nil**)

}

**@objc** **func** saveCompleted(\_ image: UIImage, didFinishSavingWithError error: Error?, contextInfo: UnsafeRawPointer){

print("Save finished!")

}

}

With that, we can now use it from SwiftUI, by adding a second button after the one to select the images.

Button("Save Image") {

**guard** **let** inputImage = inputImage **else** { **return** }

**let** imageSaver = ImageSaver()

imageSaver.writeToPhotoAlbum(image: inputImage)

}

## Building our basic UI

The UI for this project will look like this (at the beginning)

**struct** ContentView: View {

@State **private** **var** image: Image?

@State **private** **var** filterIntensity = 0.5

**var** body: **some** View {

NavigationView {

VStack {

ZStack {

Rectangle()

.fill(.secondary)

Text("Tap to select a picture")

.foregroundColor(.white)

.font(.headline)

image?

.resizable()

.scaledToFit()

}

.onTapGesture {

// select an image

}

HStack {

Text("Intensity")

Slider(value: $filterIntensity)

}

.padding(.vertical)

HStack{

Button("Change Filter") {

// change filter

}

Spacer()

Button("Save") {

// Save the picture

}

}

}

.padding([.horizontal, .bottom])

.navigationTitle("Instafilter")

}

}

}

With the ZStack, the text below the optional view will automatically be obscured when a picture has been loaded by the user.

## Importing an image into SwiftUI using PHPickerViewController

Now, the code will be updated to this:  
  
**struct** ContentView: View {

@State **private** **var** image: Image?

@State **private** **var** filterIntensity = 0.5

@State **private** **var** showingImagePicker = **false**

@State **private** **var** inputImage: UIImage?

**var** body: **some** View {

NavigationView {

VStack {

ZStack {

Rectangle()

.fill(.secondary)

Text("Tap to select a picture")

.foregroundColor(.white)

.font(.headline)

image?

.resizable()

.scaledToFit()

}

.onTapGesture {

// select an image

showingImagePicker = **true**

}

HStack {

Text("Intensity")

Slider(value: $filterIntensity)

}

.padding(.vertical)

HStack{

Button("Change Filter") {

// change filter

}

Spacer()

Button("Save") {

// Save the picture

}

}

}

.padding([.horizontal, .bottom])

.navigationTitle("Instafilter")

.onChange(of: inputImage) { \_ **in** loadImage() }

.sheet(isPresented: $showingImagePicker){

ImagePicker(image: $inputImage)

}

}

}

**func** loadImage(){

**guard** **let** inputImage = inputImage **else** { **return** }

image = Image(uiImage: inputImage)

}

}

Some things to note here:

* The showingImagePicker is used to track if the image picker is being shown or not.
* We set that value to true when the big gray rectangle is tapped.
* The inputImage is the property we pass to the ImagePicker struct, which has a @Binding property attached to a UIImage. When the **@Binding** property changes, the external value changes as well, which lets us read the value.
* We included the loadImage method that will be called when the ImagePicker view has been dismissed. For now, it will just place the selected image directly into the UI.
* We can then call that whenever our **inputImage** value changes, by attaching an **onChange()** modifier somewhere in **ContentView** – it really doesn’t matter where, but after **navigationTitle()** would seem sensible.
* Finally, we add the sheet() modifier that uses the showingImagePicker as condition and present an ImagePicker bound to inputImage as its contents.

## Basic image filtering using Core Image

Now the code, have been updated to this:

**import** CoreImage

**import** CoreImage.CIFilterBuiltins

**import** SwiftUI

**struct** ContentView: View {

@State **private** **var** image: Image?

@State **private** **var** filterIntensity = 0.5

@State **private** **var** showingImagePicker = **false**

@State **private** **var** inputImage: UIImage?

@State **private** **var** currentFilter = CIFilter.sepiaTone()

**let** context = CIContext()

**var** body: **some** View {

NavigationView {

VStack {

ZStack {

Rectangle()

.fill(.secondary)

Text("Tap to select a picture")

.foregroundColor(.white)

.font(.headline)

image?

.resizable()

.scaledToFit()

}

.onTapGesture {

// select an image

showingImagePicker = **true**

}

HStack {

Text("Intensity")

Slider(value: $filterIntensity)

.onChange(of: filterIntensity) { \_ **in** applyProcessing() }

}

.padding(.vertical)

HStack{

Button("Change Filter") {

// change filter

}

Spacer()

Button("Save") {

// Save the picture

save()

}

}

}

.padding([.horizontal, .bottom])

.navigationTitle("Instafilter")

.onChange(of: inputImage) { \_ **in** loadImage() }

.sheet(isPresented: $showingImagePicker){

ImagePicker(image: $inputImage)

}

}

}

**func** loadImage(){

**guard** **let** inputImage = inputImage **else** { **return** }

**let** beginImage = CIImage(image: inputImage)

currentFilter.setValue(beginImage, forKey: kCIInputImageKey)

applyProcessing()

}

**func** save(){

}

**func** applyProcessing(){

currentFilter.intensity = Float(filterIntensity)

**guard** **let** outputImage = currentFilter.outputImage **else** { **return** }

**if** **let** cgimg = context.createCGImage(outputImage, from: outputImage.extent){

**let** uiImage = UIImage(cgImage: cgimg)

image = Image(uiImage: uiImage)

}

}

}

Notes for this part:

* We have added the imports for CoreImage and CoreImage.CIFilterterBuiltins.
* A Core Image context is an object that’s responsible for rendering a **CIImage** to a **CGImage**, or in more practical terms an object for converting the recipe for an image into an actual series of pixels we can work with.
* Context are expensive to create, so a good idea is to create a context once and keep it alive.
* We are using a specific filter or a default one (CIFilter.speiaTone())
* We add a method (applyProcessing) that will process whatever image was imported. It will set the sepia’s filter intensisty based on the value in the filterIntensity, read the output image back from the filter, ask our CIContext to render it, then place the result into our image property so it’s visible on-screen.
* We also change the way loadImage works. Now, send whatever image was chosen into the sepia tone filter, then call **applyProcessing()** to make the magic happen.
* Finally, we need to add the onChange() modifier, in this case, to the Slider, to trigger the applyProcessing method when the value of the filterIntensity has been changed.

## Customizing our filter using confirmationDialog()

In this part we will offer the user more filters to apply to the image. The code now looks like this:

**import** CoreImage

**import** CoreImage.CIFilterBuiltins

**import** SwiftUI

**struct** ContentView: View {

@State **private** **var** image: Image?

@State **private** **var** filterIntensity = 0.5

@State **private** **var** showingImagePicker = **false**

@State **private** **var** inputImage: UIImage?

@State **private** **var** currentFilter: CIFilter = CIFilter.sepiaTone()

**let** context = CIContext()

@State **private** **var** showingFilterSheet = **false**

**var** body: **some** View {

NavigationView {

VStack {

ZStack {

Rectangle()

.fill(.secondary)

Text("Tap to select a picture")

.foregroundColor(.white)

.font(.headline)

image?

.resizable()

.scaledToFit()

}

.onTapGesture {

// select an image

showingImagePicker = **true**

}

HStack {

Text("Intensity")

Slider(value: $filterIntensity)

.onChange(of: filterIntensity) { \_ **in** applyProcessing() }

}

.padding(.vertical)

HStack{

Button("Change Filter") {

showingFilterSheet = **true**

}

Spacer()

Button("Save", action: save)

}

}

.padding([.horizontal, .bottom])

.navigationTitle("Instafilter")

.onChange(of: inputImage) { \_ **in** loadImage() }

.sheet(isPresented: $showingImagePicker){

ImagePicker(image: $inputImage)

}

.confirmationDialog("Select a filter", isPresented: $showingFilterSheet){

Button("Crystallize") { setFilter(CIFilter.crystallize()) }

Button("Edges") { setFilter(CIFilter.edges()) }

Button("Gaussian Blur") { setFilter(CIFilter.gaussianBlur()) }

Button("Pixellate") { setFilter(CIFilter.pixellate()) }

Button("Sepia Tone") { setFilter(CIFilter.sepiaTone()) }

Button("Unsharp Mask") { setFilter(CIFilter.unsharpMask()) }

Button("Vignette") { setFilter(CIFilter.vignette()) }

Button("Cancel", role: .cancel) { }

}

}

}

**func** loadImage(){

**guard** **let** inputImage = inputImage **else** { **return** }

**let** beginImage = CIImage(image: inputImage)

currentFilter.setValue(beginImage, forKey: kCIInputImageKey)

applyProcessing()

}

**func** save(){

}

**func** applyProcessing(){

**let** inputKeys = currentFilter.inputKeys

**if** inputKeys.contains(kCIInputIntensityKey) {

currentFilter.setValue(filterIntensity, forKey: kCIInputIntensityKey)

}

**if** inputKeys.contains(kCIInputRadiusKey) {

currentFilter.setValue(filterIntensity \* 200, forKey: kCIInputRadiusKey)

}

**if** inputKeys.contains(kCIInputScaleKey) {

currentFilter.setValue(filterIntensity \* 10, forKey: kCIInputScaleKey)

}

**guard** **let** outputImage = currentFilter.outputImage **else** { **return** }

**if** **let** cgimg = context.createCGImage(outputImage, from: outputImage.extent){

**let** uiImage = UIImage(cgImage: cgimg)

image = Image(uiImage: uiImage)

}

}

**func** setFilter(\_ filter: CIFilter){

currentFilter = filter

loadImage()

}

}

* We had to add a new property to show the confirmation dialog to choose a new filter.
* The property currentFilter is now of type CIFilter to indicate that it will accept different filters.
* We add a confirmationDialog with different buttons that will call a new method called setFilter and it will specify the new filter to apply.
* The setFilter method will change the currentfilter property and will automatically load the image to appy the filter.
* The applyProcessing method will validate the inputs to apply to the filter, for example, if the filter accepts the intensity or the radius or the scale and it will change the value according to every type.

## Saving the filtered image using UIImageWriteToSavedPhotosAlbum()

To complete this project, and save the filtered image, we need to make some changes. The final code of our ContentView will have this:

**struct** ContentView: View {

@State **private** **var** image: Image?

@State **private** **var** filterIntensity = 0.5

@State **private** **var** showingImagePicker = **false**

@State **private** **var** inputImage: UIImage?

@State **private** **var** processedImage: UIImage?

@State **private** **var** currentFilter: CIFilter = CIFilter.sepiaTone()

**let** context = CIContext()

@State **private** **var** showingFilterSheet = **false**

**var** body: **some** View {

NavigationView {

VStack {

ZStack {

Rectangle()

.fill(.secondary)

Text("Tap to select a picture")

.foregroundColor(.white)

.font(.headline)

image?

.resizable()

.scaledToFit()

}

.onTapGesture {

// select an image

showingImagePicker = **true**

}

HStack {

Text("Intensity")

Slider(value: $filterIntensity)

.onChange(of: filterIntensity) { \_ **in** applyProcessing() }

}

.padding(.vertical)

HStack{

Button("Change Filter") {

showingFilterSheet = **true**

}

Spacer()

Button("Save", action: save)

}

}

.padding([.horizontal, .bottom])

.navigationTitle("Instafilter")

.onChange(of: inputImage) { \_ **in** loadImage() }

.sheet(isPresented: $showingImagePicker){

ImagePicker(image: $inputImage)

}

.confirmationDialog("Select a filter", isPresented: $showingFilterSheet){

Button("Crystallize") { setFilter(CIFilter.crystallize()) }

Button("Edges") { setFilter(CIFilter.edges()) }

Button("Gaussian Blur") { setFilter(CIFilter.gaussianBlur()) }

Button("Pixellate") { setFilter(CIFilter.pixellate()) }

Button("Sepia Tone") { setFilter(CIFilter.sepiaTone()) }

Button("Unsharp Mask") { setFilter(CIFilter.unsharpMask()) }

Button("Vignette") { setFilter(CIFilter.vignette()) }

Button("Cancel", role: .cancel) { }

}

}

}

**func** loadImage(){

**guard** **let** inputImage = inputImage **else** { **return** }

**let** beginImage = CIImage(image: inputImage)

currentFilter.setValue(beginImage, forKey: kCIInputImageKey)

applyProcessing()

}

**func** save(){

**guard** **let** processedImage = processedImage **else** { **return** }

**let** imageSaver = ImageSaver()

imageSaver.successHandler = {

print("Success!")

}

imageSaver.errorHandler = {

print("Oops! \($0.localizedDescription)")

}

imageSaver.writeToPhotoAlbum(image: processedImage)

}

**func** applyProcessing(){

**let** inputKeys = currentFilter.inputKeys

**if** inputKeys.contains(kCIInputIntensityKey) {

currentFilter.setValue(filterIntensity, forKey: kCIInputIntensityKey)

}

**if** inputKeys.contains(kCIInputRadiusKey) {

currentFilter.setValue(filterIntensity \* 200, forKey: kCIInputRadiusKey)

}

**if** inputKeys.contains(kCIInputScaleKey) {

currentFilter.setValue(filterIntensity \* 10, forKey: kCIInputScaleKey)

}

**guard** **let** outputImage = currentFilter.outputImage **else** { **return** }

**if** **let** cgimg = context.createCGImage(outputImage, from: outputImage.extent){

**let** uiImage = UIImage(cgImage: cgimg)

image = Image(uiImage: uiImage)

processedImage = uiImage

}

}

**func** setFilter(\_ filter: CIFilter){

currentFilter = filter

loadImage()

}

}

But besides the changes here, we also have to update the ImageSaver.swift class we previously created:

**class** ImageSaver: NSObject {

**var** successHandler: (() -> Void)?

**var** errorHandler: ((Error) -> Void)?

**func** writeToPhotoAlbum(image: UIImage){

UIImageWriteToSavedPhotosAlbum(image, **self**, **#selector**(saveCompleted), **nil**)

}

**@objc** **func** saveCompleted(\_ image: UIImage, didFinishSavingWithError error: Error?, contextInfo: UnsafeRawPointer){

// If there is an error, pass the error to the errorHandler

**if** **let** error = error {

errorHandler?(error)

} **else** {

successHandler?()

}

}

}

Important things to note:

* The ImageSaver has now two handlers, one for the success result and another one for the error result. Both are optional and this allows us to do something when the operation to save the image failed.
* We need to remember that we need to add the “Privacy – Photo Library Additions Usage Description” in the target settings of the project, because the app will ask the user for the permission to save images.
* We have added a new property called processedImage to save the UIImage generated in the applyProcessing method, because we need a UIImage to send to the ImageSaver class.
* In the save() method, we checked the processedImage has something and create a ImageSaver object.
* Here, we define the success and error handlers, which basically will show a message in console.
* And finally we call the writeToPhotoAlbum method.

# Project 14 – Bucket List

In this project we will build an app that lets the user build a private list of places on the map that they intend to visit one day, add a description for that place, look up interesting places that are nearby, and save it all to the iOS storage for later

## Adding conformance to Comparable for custom types

We can compare all the integers in an array to decide whether each one should come before or after the others. Swift then uses that result to sort the array

A simple example using numbers:

struct \_1\_CompareCustomTypes: View {

let values = [1, 5, 3, 6, 2, 9].sorted()

var body: some View {

List(values, id: \.self) {

Text(String($0))

}

}

}

But if we have the following code:

struct User: Identifiable {

let id = UUID()

let firstName: String

let lastName: String

}

struct \_1\_CompareCustomTypes: View {

let users = [

User(firstName: "Arnold", lastName: "Rimmer"),

User(firstName: "Kristine", lastName: "Kochanski"),

User(firstName: "David", lastName: "Lister"),

]

var body: some View {

List(users) { user in

Text("\(user.lastName), \(user.firstName)")

}

}

}

If we try to use .sorted() for the users list, it won't work, because it won't know whether to sort by first name, last name, both or something else.

One way is to use a closure like this one:

let users = [

User(firstName: "Arnold", lastName: "Rimmer"),

User(firstName: "Kristine", lastName: "Kochanski"),

User(firstName: "David", lastName: "Lister"),

].sorted {

$0.lastName < $1.lastName

}

But it is not ideal for 2 reasons:

* This is model data. The struct and its properties are our data model, and we should not tel the model how it should behave inside our SwiftUI code. SwiftUI represents the view, and if we put model code in there then things get confused.
* If we want to sort User arrays in multiple places, you might copy and paste the closure one or twice creating a soring logic problem.

Arrays of integers get a simple sorted() method because Int conforms to the Comparable protocol, which means it defines a function that takes two integers and returns true if the first should be sorted before the second

We can make our own types conform to Comparable getting a sorted() method with no parameters. For that:

* Add the Comparable conformance to the definition of User.
* Add a method called < that takes two users and returns true if the first should be sorted before the second.

struct User: Identifiable, Comparable {

let id = UUID()

let firstName: String

let lastName: String

static func <(lhs: User, rhs: User) -> Bool {

lhs.lastName < rhs.lastName

}

}

We are doing what is called "operator overloading" with the less than operator.

lhs and rhs are the conventions for "left-hand side" and "right-hand side".

Third, this method must return a Boolean, which means we must decide whether one object should be sorted before another. There is no room for “they are the same” here – that’s handled by another protocol called Equatable

Fourth, the method must be marked as static, which means it’s called on the User struct directly rather than a single instance of the struct

Now that our User struct conforms to Comparable, we automatically get access to the parameter-less version of sorted(), which means this kind of code works now:

let users = [

User(firstName: "Arnold", lastName: "Rimmer"),

User(firstName: "Kristine", lastName: "Kochanski"),

User(firstName: "David", lastName: "Lister"),

].sorted()

This resolves the problems we had before: we now isolate our model functionality in the struct itself, and we no longer need to copy and paste code around – we can use sorted() everywhere, safe in the knowledge that if we ever change the algorithm then all our code will adapt

## Writing data to the documents directory

UserDefaults is a great place to store user settings or small amounts of JSON, but not to store data. iOS makes it very easy to read and write data from device storage, and in fact all apps get a directory for storing any kind of documents we want. Files here are automatically synchronized with iCloud backups, so if the user gets a new device then our data will be restored along with all the other system data

All iOS apps are sandboxed, which means they run in their own container with a hard to guess directory name. As a result, we can’t – and shouldn’t try to – guess the directory where our app is installed, and instead need to rely on Apple’s API for finding our app’s documents directory

The following is a method that uses FileManager, which can provide us with the document directory for the current user. In theory this can return several path URLs, but we only ever care about the first one

That documents directory is ours to do with as we please, and because it belongs to the app it will automatically get deleted if the app itself gets deleted.

You already met String(contentsOf:) and Data(contentsOf:) for reading data, but for writing data we need to use the write(to:) method. When used with strings this takes three parameters:

1. A URL to write to.

2. Whether to make the write atomic, which means “all at once”.

3. What character encoding to use

We have the following code for that:

struct \_2\_WriteData: View {

var body: some View {

Text(/\*@START\_MENU\_TOKEN@\*/"Hello, World!"/\*@END\_MENU\_TOKEN@\*/)

.onTapGesture {

let str = "Test Message"

let url = getDocumentsDirectory().appendingPathComponent("message.txt")

do {

try str.write(to: url, atomically: true, encoding: .utf8)

let input = try String(contentsOf: url)

print(input)

} catch {

print(error.localizedDescription)

}

}

}

func getDocumentsDirectory() -> URL {

// find all possible documents directories for this user

let paths = FileManager.default.urls(for: .documentDirectory, in: .userDomainMask)

// just send back the first one, which ought to be the only one

return paths[0]

}

}

## Switching view states with enums

Where conditional views are particularly useful is when we want to show one of several different states, and if we plan it correctly we can keep our view code small and also easy to maintain.

First thing we can do is to define an enum for the various view states you want to represent and then, you can create different views for those states.

**enum** LoadingState {

**case** loading, success, failed

}

**struct** LoadingView: View {

**var** body: **some** View {

Text("Loading...")

}

}

**struct** SuccessView: View {

**var** body: **some** View {

Text("Success!")

}

}

**struct** FailedView: View {

**var** body: **some** View {

Text("Failed.")

}

}

**struct** \_3\_SwitchViews: View {

**var** loadingState = LoadingState.loading

**var** body: **some** View {

**if** loadingState == .loading {

LoadingView()

} **else** **if** loadingState == .success {

SuccessView()

} **else** **if** loadingState == .failed {

FailedView()

}

}

}

**Tip:** When returning different kinds of view, make sure you’re either inside the **body** property or using something like **@ViewBuilder** or **Group**.

## Integrating MapKit with SwiftUI

Apple provides a SwiftUI **Map** view that wraps up the underlying map framework beautifully, letting us place maps, annotations, and more alongside the rest of our SwiftUI view hierarchy.

Showing a map means creating some program state that stores the map’s current center coordinate and zoom level, which is handled through a dedicated type called **MKCoordinateRegion**.

We need to import the MapKit.

Then we can create a property to define the coordinate region and finally we can use a Map view, That has a two-way binding to the region so it can be updated as the user moves around the map

**struct** \_4\_MapKitExample: View {

@State **private** **var** mapRegion = MKCoordinateRegion(

center: CLLocationCoordinate2D(latitude: 51.5, longitude: -0.12),

span: MKCoordinateSpan(latitudeDelta: 0.2, longitudeDelta: 0.2))

**var** body: **some** View {

Map(coordinateRegion: $mapRegion)

}

}

We can add annotations to the map, that are markers that represent various places of our choosing. This takes at least three steps:

* Defining a new data type that contains your location.
* Create an array of those containing all your locations.
* Adding them as annotations in the map.

Whatever new data type you create to store locations, it *must* conform to the **Identifiable** protocol so that SwiftUI can identify each map marker uniquely.

We can also make the annotation look like red circles:

// 1. Define a new type for the location

**struct** Location: Identifiable {

**let** id = UUID()

**let** name: String

**let** coordinate: CLLocationCoordinate2D

}

**struct** \_4\_MapKitExample: View {

@State **private** **var** mapRegion = MKCoordinateRegion(

center: CLLocationCoordinate2D(latitude: 51.5, longitude: -0.12),

span: MKCoordinateSpan(latitudeDelta: 0.2, longitudeDelta: 0.2))

// 2. Create an array containing the locations

**let** locations = [

Location(name: "Buckingham Palace", coordinate:

CLLocationCoordinate2D(latitude: 51.501, longitude: -0.141)),

Location(name: "Tower of London", coordinate:

CLLocationCoordinate2D(latitude: 51.508, longitude: -0.076)),

]

**var** body: **some** View {

Map(coordinateRegion: $mapRegion, annotationItems: locations){ location **in**

// 3. Adding annotations

MapAnnotation(coordinate: location.coordinate) {

Circle()

.stroke(.red, lineWidth: 3)

.frame(width: 44, height: 44)

}

}

}

}

We could even place a NavigationLink into our map annotation, directing the user to a different view when the annotation was tapped:

**import** MapKit

**import** SwiftUI

// 1. Define a new type for the location

**struct** Location: Identifiable {

**let** id = UUID()

**let** name: String

**let** coordinate: CLLocationCoordinate2D

}

**struct** \_4\_MapKitExample: View {

@State **private** **var** mapRegion = MKCoordinateRegion(

center: CLLocationCoordinate2D(latitude: 51.5, longitude: -0.12),

span: MKCoordinateSpan(latitudeDelta: 0.2, longitudeDelta: 0.2))

// 2. Create an array containing the locations

**let** locations = [

Location(name: "Buckingham Palace", coordinate:

CLLocationCoordinate2D(latitude: 51.501, longitude: -0.141)),

Location(name: "Tower of London", coordinate:

CLLocationCoordinate2D(latitude: 51.508, longitude: -0.076)),

]

**var** body: **some** View {

NavigationView{

Map(coordinateRegion: $mapRegion, annotationItems: locations){ location **in**

// 3. Adding annotations

MapAnnotation(coordinate: location.coordinate) {

NavigationLink {

Text(location.name)

} label: {

Circle()

.stroke(.red, lineWidth: 3)

.frame(width: 44, height: 44)

.onTapGesture {

print("Tapped on \(location.name)")

}

}

}

}

}

.navigationTitle("London Explorer")

}

}

## Using Touch ID and Face ID with SwiftUI

Touch ID and Face ID are available but they are also another Objective-C API. First, you need to add a new key to your project options, explaining to the user why you want access to Face ID.

So, select your current target, go to the Info tab, right-click on an existing key, then choose Add Row. Scroll through the list of keys until you find “Privacy - Face ID Usage Description” and give it the value “We need to unlock your data.”

We need the following import:

import LocalAuthentication

Swift developers use the **Error** protocol for representing errors that occur at runtime, but Objective- C uses a special class called **NSError**. We need to be able to pass that into the function and have it changed *inside* the function rather than returning a new value – although this was the standard in Objective-C, it’s quite an alien way of working in Swift so we need to mark this behavior specially by using **&**.

We’re going to write an **authenticate()** method that isolates all the biometric functionality in a single place.

1. Create instance of **LAContext**, which allows us to query biometric status and perform the authentication check.

2. Ask that context whether it’s capable of performing biometric authentication – this is important because iPod touch has neither Touch ID nor Face ID.

3. If biometrics are possible, then we kick off the actual request for authentication, passing in a closure to run when authentication completes.

4. When the user has either been authenticated or not, our completion closure will be called and tell us whether it worked or not, and if not what the error was.

**import** SwiftUI

**import** LocalAuthentication

**struct** \_5\_TouchIdExample: View {

// This will store whether the app is showing its protected data or not

@State **private** **var** isUnlocked = **false**

**var** body: **some** View {

VStack {

**if** isUnlocked {

Text("Unlocked")

} **else** {

Text("Locked")

}

}

.onAppear(perform: authenticate)

}

**func** authenticate(){

**let** context = LAContext()

**var** error: NSError?

// Check whether biometric authentication is possible

**if** context.canEvaluatePolicy(.deviceOwnerAuthenticationWithBiometrics, error: &error) {

// it's possible, so go ahead and use it

**let** reason = "We need to unlock your data."

context.evaluatePolicy(.deviceOwnerAuthenticationWithBiometrics, localizedReason: reason) { success, authenticationError **in**

// authentication has now completed

**if** success {

// authenticated successfully

isUnlocked = **true**

} **else** {

// there was a problem

}

}

} **else** {

// no biometrics

}

}

}

The simulator is not opted in to biometrics by default, and there are no error messages, so it fails silently.

To take Face ID for a test drive, go to the Features menu and choose Face ID > Enrolled, then launch the app again. This time you should see the Face ID prompt appear, and you can trigger successful or failed authentication by going back to the Features menu and choosing Face ID > Matching Face or Non-matching Face.

## Adding user locations to a map

We’re going to start with a full-screen **Map** view, then place a translucent circle on top to represent the center point. To do this, we will use the Zstack.

**import** SwiftUI

**import** MapKit

**struct** \_6\_AddUserLocations: View {

@State **private** **var** mapRegion = MKCoordinateRegion(center: CLLocationCoordinate2D(latitude: 50, longitude: 0), span: MKCoordinateSpan(latitudeDelta: 25, longitudeDelta: 25))

**var** body: **some** View {

ZStack {

Map(coordinateRegion: $mapRegion)

.ignoresSafeArea()

Circle()

.fill(.blue)

.opacity(0.3)

.frame(width: 32, height: 32)

VStack {

Spacer()

HStack {

Spacer()

Button {

// Create a new locatin

} label: {

Image(systemName: "plus")

}

.padding()

.background(.black.opacity(0.75))

.foregroundColor(.white)

.font(.title)

.clipShape(Circle())

.padding(.trailing)

}

}

}

}

}

Some important things to note:

The property mapRegion starts the map so that most of Western Europe and North Africa are visible.

The plus button is placed to the bottom right using a Vstack and a Hstack with spacers before each one.

We have added paddign twice: one is to make sure the button is bigger beore we add a background color, and the second time to push it away from the trailing edge.

Where things get *interesting* is how we place locations on the map. We’ve bound the location of the map to a property in **ContentView**, but now we need to send in an array of locations we want to show.

We will create now a Swift file called Location.swift that conforms the following protocols:

* Identifiable, so we can create many location markers in our map.
* Codable, so we can load and save map data easily.
* Equatable, so we can find one particular location in an array of locations.

**struct** \_6\_Location: Identifiable, Codable, Equatable {

**let** id: UUID

**var** name: String

**var** description: String

**let** latitude: Double

**let** longitude: Double

}

To add new markers to the map, update the code to this:

**struct** \_6\_AddUserLocations: View {

@State **private** **var** mapRegion = MKCoordinateRegion(center: CLLocationCoordinate2D(latitude: 50, longitude: 0), span: MKCoordinateSpan(latitudeDelta: 25, longitudeDelta: 25))

@State **private** **var** locations = [\_6\_Location]()

**var** body: **some** View {

ZStack {

Map(coordinateRegion: $mapRegion, annotationItems: locations){

location **in**

MapMarker(coordinate: CLLocationCoordinate2D(latitude: location.latitude, longitude: location.longitude))

}

.ignoresSafeArea()

Circle()

.fill(.blue)

.opacity(0.3)

.frame(width: 32, height: 32)

VStack {

Spacer()

HStack {

Spacer()

Button {

// Create a new location

**let** newLocation = \_6\_Location(id: UUID(), name: "New Location", description: "", latitude: mapRegion.center.latitude, longitude: mapRegion.center.longitude)

locations.append(newLocation)

} label: {

Image(systemName: "plus")

}

.padding()

.background(.black.opacity(0.75))

.foregroundColor(.white)

.font(.title)

.clipShape(Circle())

.padding(.trailing)

}

}

}

}

}

## Improving our map annotations

Replace the MapMarker with the following code:

MapAnnotation(coordinate: CLLocationCoordinate2D(latitude:

location.latitude, longitude: location.longitude)) {

VStack {

Image(systemName: "star.circle")

.resizable()

.foregroundColor(.red)

.frame(width: 44, height: 44)

.background(.white)

.clipShape(Circle())

Text(location.name)

}

}

But, move the CLLocationCoordinate2D to the location file:

**struct** Location: Identifiable, Codable, Equatable {

**let** id: UUID

**var** name: String

**var** description: String

**let** latitude: Double

**let** longitude: Double

**var** coordinate: CLLocationCoordinate2D {

CLLocationCoordinate2D(latitude: latitude, longitude: longitude)

}

}

Now, the ContentView code is simpler:

**var** body: **some** View {

ZStack {

Map(coordinateRegion: $mapRegion, annotationItems: locations){

location **in**

MapAnnotation(coordinate: location.coordinate) {

We will add an example to Location struct:

**static** **let** example = Location(id: UUID(), name: "Buckingham Palace", description: "Where Queen Elizabeth lives with her dorgis", latitude: 51.501, longitude: -0.141)

Now we will add a custom == function to the struct. Location conforms Equatable, which means we can already compare one location to another using **==**

So, we can save a bunch of work by writing our own **==** function to **Location**, which compares two identifiers and nothing else:

**static** **func** ==(lhs: Location, rhs: Location) -> Bool {

lhs.id == rhs.id

}

## Selecting and editing map annotations

In this part we will show a sheet when the user selects a map annotation, giving the user the chance to view or edit details about a location.

In the ContentView, we will use a property instead of a Boolean to show the sheet:

@State private var selectedPlace: Location?

Attach this modifier to the Zstack in ContentView:

.sheet(item: $selectedPlace) { place in

Text(place.name)

}

Now, give selectedPlace a value by adding a tap gesture to the Vstack in our map annotation:

.onTapGesture {

selectedPlace = location

}

Then we will create a EdivView that allows the user to edit the values for name and description of thelocation.

In the EditView we need to create a new initializer that accepts a location and uses those values to create State structs using the location’s data. This uses the same underscore approach we used when creating a fetch request inside an initializer, which allows us to create an instance of the property wrapper not the data inside the wrapper.

**init**(location: Location) {

**self**.location = location

\_name = State(initialValue: location.name)

\_description = State(initialValue: location.description)

}

When we are editing the location, how can we pass the new location data back? We *could* use something like **@Binding** to pass in a remote value, but that creates problems with our optional in **ContentView** – we want **EditView** to be bound to a real value rather than an optional value, because otherwise it would get confusing.

We’ll require a function to call where we can pass back whatever new location we want.

We will add a new property to EditView:

**var** onSave: (Location) -> Void

That asks for a function that accepts a single location and returns nothing. We will add it to our initializer:

**init**(location: Location, onSave: **@escaping** (Location) -> Void) {

**self**.location = location

**self**.onSave = onSave

\_name = State(initialValue: location.name)

\_description = State(initialValue: location.description)

}

**@escaping** means the function is being stashed away for user later on, rather than being called immediately, and it’s needed here because the **onSave** function will get called only when the user presses Save.

We need to update the Save button to create a new location with the modified details:

Button("Save") {

**var** newLocation = location

newLocation.name = name

newLocation.description = description

onSave(newLocation)

dismiss()

}

Update also the preview code:

EditView(location: Location.example) { newLocation in }

In the ContentView we can use the EditView in the sheet modifier:

.sheet(item: $selectedPlace) { place **in**

EditView(location: place) { newLocation **in**

**if** **let** index = locations.firstIndex(of: place) {

locations[index] = newLocation

}

}

}

We are also passing a closure to run when the Save button is pressed. That accepts the new location, then looks up where the *current* location is and replaces it in the array. This will cause our map to update immediately with the new data.

We have to update the id property and make mutable because two places can have identical IDs, – when we update a marker so it has a different name, SwiftUI will compare the old marker and new one, see that their IDs are the same, and therefore not bother to change the map.

var id: UUID

And then we adjust that when we create new locations on EditView

.toolbar {

Button("Save") {

**var** newLocation = location

newLocation.id = UUID()

newLocation.name = name

newLocation.description = description

onSave(newLocation)

dismiss()

}

}

Finally, add the .fixedSize modifier to the Text(location.name) to avoid that the label be clipped.

## Downloading data from Wikipedia

We can query Wikipedia using GPS coordinates, and it will send back a list of places that are nearby.

Wikipedia’s API sends back JSON data in a precise format, so we need to do a little work to define **Codable** structs capable of storing it all. The structure is this:

• The main result contains the result of our query in a key called “query”.  
• Inside the query is a “pages” dictionary, with page IDs as the key and the Wikipedia pages

themselves as values.  
• Each page has a lot of information, including its coordinates, title, terms, and more.

Create a Result.swift file with the following code:

**import** Foundation

**struct** Result: Codable {

**let** query: Query

}

**struct** Query: Codable {

**let** pages: [Int: Page]

}

**struct** Page: Codable {

**let** pageid: Int

**let** title: String

**let** terms: [String: [String]]?

}

In the EditView, add an enum that stores the current load state. Also a couple of properties, one to represent the loading state and other to store an array of Wikipiedia pages once the fetch has completed.

Then we add another section in the form to show pages if they have loaded or a status text otherwise. We can use +to add views together.

The fetchNearbyPlaces is a method to get the data from Wikipedia API. To request that data add the task() modifier after the existing toolbar modifier.

The complete EditView should look like this:

**import** SwiftUI

**struct** EditView: View {

@Environment(\.dismiss) **var** dismiss

**var** location: Location

@State **private** **var** name: String

@State **private** **var** description: String

**enum** LoadingState {

**case** loading, loaded, failed

}

@State **private** **var** loadingState = LoadingState.loading

@State **private** **var** pages = [Page]()

**var** onSave: (Location) -> Void

**var** body: **some** View {

NavigationView {

Form {

Section {

TextField("Place name", text: $name)

TextField("Description", text: $description)

}

Section("Nearby..."){

**switch** loadingState {

**case** .loaded:

ForEach(pages, id: \.pageid) { page **in**

Text(page.title)

.font(.headline)

+ Text(": ") +

Text("Page description here")

.italic() }

**case** .loading:

Text("Loading...")

**case** .failed:

Text("Please try again later.")

}

}

}

.navigationTitle("Place details")

.toolbar {

Button("Save") {

**var** newLocation = location

newLocation.id = UUID()

newLocation.name = name

newLocation.description = description

onSave(newLocation)

dismiss()

}

} .task {

**await** fetchNearbyPlaces()

}

}

}

**init**(location: Location, onSave: **@escaping** (Location) -> Void) {

**self**.location = location

**self**.onSave = onSave

\_name = State(initialValue: location.name)

\_description = State(initialValue: location.description)

}

**func** fetchNearbyPlaces() **async** {

**let** urlString = "https://en.wikipedia.org/w/api.php?ggscoord=\(location.latitude)%7C\(location.longitude)&action=query&prop=coordinates%7Cpageimages%7Cpageterms&colimit=50&piprop=thumbnail&pithumbsize=500&pilimit=50&wbptterms=description&generator=geosearch&ggsradius=10000&ggslimit=50&format=json"

**guard** **let** url = URL(string: urlString) **else** {

print("Bad URL: \(urlString)")

**return**

}

**do** {

**let** (data, \_) = **try** **await** URLSession.shared.data(from: url)

// We got some data back!

**let** items = **try** JSONDecoder().decode(Result.**self**, from: data)

// Success - Convert the array values to our pages array

pages = items.query.pages.values.sorted { $0.title < $1.title }

loadingState = .loaded

} **catch** {

// If we're still here it means the request failed somehow

loadingState = .failed

}

}

}

## Sorting Wikipedia results

Rather than just provide an inline closure to sorted() we are going to make our Page struct conform to Comparable.

To conform Comparable we must implement a < function that accepts two parameters of the type of our struct, and returns true if the first should be sorted before the second.

We will add another property called description in the Page struct if the terms dictionary has a description key.

**struct** Page: Codable, Comparable {

**let** pageid: Int

**let** title: String

**let** terms: [String: [String]]?

**var** description: String {

terms?["description"]?.first ?? "No further information"

}

**static** **func** < (lhs: Page, rhs: Page) -> Bool {

lhs.title < rhs.title

}

}

With this property, we can change the Text(“page description here”) with the description property:

Section("Nearby..."){

**switch** loadingState {

**case** .loaded:

ForEach(pages, id: \.pageid) { page **in**

Text(page.title)

.font(.headline)

+ Text(": ") +

Text(page.description)

.italic() }

**case** .loading:

Text("Loading...")

**case** .failed:

Text("Please try again later.")

}

}

## Introducing MVVM into your SwiftUI project

We will create a ContentView-ViewModel.swift file with a class that manages the data, and manipulates it on behalf of the ContentView struct so that our view doesn’t really care how the underlying data system works.

The extention ContentView will have the ViewModel class in it, which indicates this is view model for ContentView.

The main actor is responsible for running all user interface updates, and adding that attribute to the class means we want all its code – any time it runs anything, unless we specifically ask otherwise – to run on that main actor. This is important because it’s responsible for making UI updates, and those must happen on the main actor.

Without using @MainActor, whenever we use **@StateObject** or **@ObservedObject** Swift was silently inferring the **@MainActor** attribute for us. But what if you access your class from somewhere else? Then the code could run anywhere, which isn’t safe.

With the @MainActor we are telling Swift every part of this class should run on the main actor, so it’s safe to update the UI, no matter where it’s used.

From the ContentView, we will move the frist three properties (mapRegion, locations and selectedPlace) into the ContentViewViewModel. Then, in the CVVM class, we will access all those properties with the viewModel object (private var viewModel).

Views work best when they handle presentation of data, meaning that *manipulation* of data is a great candidate for code to move into a view model.

*Reading* data data from a view model’s properties is usually fine, but *writing* it isn’t. In the example we modify the locations property in the view model to this:

@Published **private**(**set**) **var** locations:[Location]

Adding a new location an updating an existing one will require a change, so we have added the addLocation method in the ContentView-ViewModel class.

**func** addLocation() {

**let** newLocation = Location(id: UUID(), name: "New Location", description: "", latitude: mapRegion.center.latitude, longitude: mapRegion.center.longitude)

locations.append(newLocation)

save()

}

And in the ContentView, where we add a new location, we can now call this method like this:

viewModel.addLocation()

To update an existing location, we can add a new method called update:

**func** update(location: Location){

**guard** **let** selectedPlace = selectedPlace **else** { **return** }

**if** **let** index = locations.firstIndex(of: selectedPlace) {

locations[index] = location

save()

}

}

Now we can save and load the data, by using the FileManager extension class, This will look in the documents directory for a particular file, then use either **JSONEncoder** or **JSONDecoder** to convert it ready for use:

**import** Foundation

**extension** FileManager {

**static** **var** documentsDirectory: URL {

**let** paths = FileManager.default.urls(for: .documentDirectory,

in: .userDomainMask)

**return** paths[0]

}

}

Then we can define a new property in the view model to store the location we’re saving to:

// Define a store location for the places we are saving

**let** savePath = FileManager.documentsDirectory.appendingPathComponent("SavedPlaces")

And aftert that, we can create a new initializer and a new save() that makes the data persisted automatically.

The completeFileProtection in the save method ensures that the file is stored with strong encryption.

This way, ContentView should look like this:

**import** SwiftUI

**import** MapKit

**struct** ContentView: View {

@StateObject **private** **var** viewModel = ViewModel()

**var** body: **some** View {

ZStack {

Map(coordinateRegion: $viewModel.mapRegion, annotationItems: viewModel.locations){

location **in**

MapAnnotation(coordinate: location.coordinate) {

VStack {

Image(systemName: "star.circle")

.resizable()

.foregroundColor(.red)

.frame(width: 44, height: 44)

.background(.white)

.clipShape(Circle())

Text(location.name)

.fixedSize()

}

.onTapGesture {

viewModel.selectedPlace = location

}

}

}

.ignoresSafeArea()

Circle()

.fill(.blue)

.opacity(0.3)

.frame(width: 32, height: 32)

VStack {

Spacer()

HStack {

Spacer()

Button {

// Create a new location

viewModel.addLocation()

} label: {

Image(systemName: "plus")

}

.padding()

.background(.black.opacity(0.75))

.foregroundColor(.white)

.font(.title)

.clipShape(Circle())

.padding(.trailing)

}

}

}

.sheet(item: $viewModel.selectedPlace) { place **in**

EditView(location: place) {

viewModel.update(location: $0)

}

}

}

}

#Preview {

ContentView()

}

And the ContentView-ViewModel.swift should look like this:

**import** Foundation

**import** MapKit

**import** SwiftUI

**extension** ContentView {

@MainActor **class** ViewModel: ObservableObject {

@Published **var** mapRegion = MKCoordinateRegion(

center: CLLocationCoordinate2D(latitude: 50, longitude: 0),

span: MKCoordinateSpan(latitudeDelta: 25, longitudeDelta: 25))

@Published **private**(**set**) **var** locations:[Location]

@Published **var** selectedPlace: Location?

// Define a store location for the places we are saving

**let** savePath = FileManager.documentsDirectory.appendingPathComponent("SavedPlaces")

**init**() {

**do** {

**let** data = **try** Data(contentsOf: savePath)

locations = **try** JSONDecoder().decode([Location].**self**, from: data)

} **catch** {

locations = []

}

}

// Saves the locations in a file and ensures it is stored with strong encryption

**func** save() {

**do** {

**let** data = **try** JSONEncoder().encode(locations)

**try** data.write(to: savePath, options:

[.atomic, .completeFileProtection])

} **catch** {

print("Unable to save data.")

}

}

**func** addLocation() {

**let** newLocation = Location(id: UUID(), name: "New Location", description: "", latitude: mapRegion.center.latitude, longitude: mapRegion.center.longitude)

locations.append(newLocation)

save()

}

**func** update(location: Location){

**guard** **let** selectedPlace = selectedPlace **else** { **return** }

**if** **let** index = locations.firstIndex(of: selectedPlace) {

locations[index] = location

}

save()

}

}

}

## Locking Our UI behind Face ID

To start, we need a new state in the view model that tracks whether the app is unlocked or not:

@Published var isUnlocked = false

Then, we need to add the FaceID permission in the project configuration options.

Third, add the import LocalAuthentication in the view model.

We will have a dedicated authenticate() method that handles all the biometric work.

The string in our code is for Touch ID, whereas the string in Info.plist is used for Face ID.

**func** authenticate(){

**let** context = LAContext()

**var** error: NSError?

**if** context.canEvaluatePolicy(.deviceOwnerAuthenticationWithBiometrics, error: &error){

**let** reason = "Please authenticate yourself to unlock your places."

context.evaluatePolicy(.deviceOwnerAuthenticationWithBiometrics, localizedReason: reason){ success, authenticationError **in**

**if** success {

Task { @MainActor **in**

**self**.isUnlocked = **true**

}

} **else** {

// error

}

}

} **else** {

// no biometrics

}

}

Then we have to make a change in the ContentView to add a validation and show everything that it is inside the ZStack only if the user has been authenticated.

**struct** ContentView: View {

@StateObject **private** **var** viewModel = ViewModel()

**var** body: **some** View {

ZStack {

**if viewModel.isUnlocked {**

Map(coordinateRegion: $viewModel.mapRegion, annotationItems: viewModel.locations){

location **in**

MapAnnotation(coordinate: location.coordinate) {

VStack {

Image(systemName: "star.circle")

.resizable()

.foregroundColor(.red)

.frame(width: 44, height: 44)

.background(.white)

.clipShape(Circle())

Text(location.name)

.fixedSize()

}

.onTapGesture {

viewModel.selectedPlace = location

}

}

}

.ignoresSafeArea()

Circle()

.fill(.blue)

.opacity(0.3)

.frame(width: 32, height: 32)

VStack {

Spacer()

HStack {

Spacer()

Button {

// Create a new location

viewModel.addLocation()

} label: {

Image(systemName: "plus")

}

.padding()

.background(.black.opacity(0.75))

.foregroundColor(.white)

.font(.title)

.clipShape(Circle())

.padding(.trailing)

}

}

**} else {**

**Button("Unlock Places") {**

**viewModel.authenticate()**

**}**

**.padding()**

**.background(.blue)**

**.foregroundColor(.white)**

**.clipShape(Capsule())**

**}**

}

.sheet(item: $viewModel.selectedPlace) { place **in**

EditView(location: place) {

viewModel.update(location: $0)

}

}

}

This will evaluate the isUnlocked property and if it is false, it will show a button to allow the user to authenticate.

In the authenticate method we use a task to change the isUnlocked property in the main actor. we can tell Swift that our task’s code needs to run directly on the main actor, by giving the closure itself the **@MainActor** attribute.

# Project 15 - Accessibility

Making your app accessible means taking steps to ensure that everyone can use it fully regardless of their individual needs. For example, if they are blind then your app should work well with the system’s VoiceOver system to ensure your UI can be read smoothly.

## Identifying views with useful Labels

In this project we will have a view that will show an image (from several options) and it will change it randomly when we tap on it. We need to enable VoiceOver in the Settings of the iOS device: Settings > Accessibility > VoiceOver, then toggle it on. Alternatively, you can activate Siri at any time and ask to enable or disable VoiceOver

The VoiceOver is going to read the name of the file along with the type, in this example, an image. To fix this, we can use the following modifiers:

.accesibilityLabel() = a text that gets right to the point.

.accessibilityHint() = is read after a short delay, and should provide more details on what the view is there for.

.accessibilityAddTraits) = this lets us provide some extra information to VoiceOver that describes how the view works. We can tell, for example, that our view is a button

You can also remove the trait with:

.accessibilityRemoveTraits(.isImage)

struct \_1\_Labels: View {

let pictures = [

"ales-krivec-15949",

"galina-n-189483",

"kevin-horstmann-141705",

"nicolas-tissot-335096"

]

let labels = [

"Tulips",

"Frozen tree buds",

"Sunflowers",

"Fireworks",

]

@State private var selectedPicture = Int.random(in: 0...3)

var body: some View {

Image(pictures[selectedPicture])

.resizable()

.scaledToFit()

.onTapGesture {

selectedPicture = Int.random(in: 0...3)

}

.accessibilityLabel(labels[selectedPicture])

.accessibilityAddTraits(.isButton)

}

}

Hiding and grouping accessibility data

The VoiceOver feature usually set the reading speed extremely fast.As a result, it’s important we ensure our UI removes as much clutter as possible so that users can navigate through it quickly and not have to listen to VoiceOver reading unhelpful descriptions.

Beyond setting labels and hints, there are several ways we can control what VoiceOver reads out. There are three in particular I want to focus on:

* Marking images as being unimportant for VoiceOver.
* Hiding views from the accessibility system.
* Grouping several views as one.

For example, we can tell SwiftUI that a particular image is just there to make the UI look better by using Image(decorative:).

Image(decorative: "character")

This leaves the image as being accessible to VoiceOver if it has some important traits, such as .isButton – it will say “button” when it’s highlighted, and if we attach a tap gesture that works - but it doesn’t read out the image’s filename as the automatic VoiceOver label.

If you want to go a step further, you can use the .accessibilityHidden() modifier, which makes any view completely invisible to the accessibility system

The last way to hide content from VoiceOver is through grouping, which lets us control how  the system reads several views that are related. As an example, consider this layout:

VStack {

Text("Your score is")

Text("100")

.font(.title)

}

VoiceOver sees two unrelated texts views and it will read either one or the other depending on what the user has selected. With .accessibilityElement(childre:) modifier, we can apply it to a parent view and ask it to combine children into a single accessibility element.

VStack {

Text("Your score is")

Text("100")

.font(.title)

}

.accessibilityElement(children: .combine)

That works really well when the child views contain separate information, but in our case the children really should be read as a single entity. So, the better solution here is to use .accessibilityElement(children: .ignore) so the child views are invisible to VoiceOver, then provide a custom label to the parent, like this:

VStack {

Text("Your score is")

Text("100")

.font(.title)

}

.accessibilityElement(children: .ignore)

.accessibilityLabel("Your score is 100")

## Reading the value of Controls

By default SwiftUI provides VoiceOver readouts for its user interface controls, and although these are often good sometimes they just don’t fit with what you need. In these situations we can use the accessibilityValue() modifier to separate a control’s value from its label, but we can also specify custom swipe actions using accessibilityAdjustableAction()

struct \_3\_ReadValueControls: View {

@State private var value = 10

var body: some View {

VStack {

Text("Value: \(value)")

Button("Increment"){

value += 1

}

Button("Decrement"){

value -= 1

}

}

.accessibilityElement()

.accessibilityLabel("Value")

.accessibilityValue(String(value))

.accessibilityAdjustableAction{ direction in

switch direction {

case .increment:

value += 1

case .decrement:

value -= 1

default:

print("Not handled.")

}

}

}

}

By grouping our VStack together using accessibilityElement and accessibilityLabel and adding accessiblityValue lets the user select the whole VStack to have "Value 10"read out, but they can swipe up or down to manipualte the value and have just the numbers read out.

## Fixing Guess the Flag

In the project Guess the Flag we show three images to the user and he must guess which on belongs to the country asked by the app. the problem is that the name of the image is the name of the country. With VoiceOver it would be easy to gues

So we can create a dictionary with the name of the country (or image) and a detailed description of the flag. Example:

let labels = [

"Estonia": "Flag with three horizontal stripes of equal size. Top stripe blue, middle stripe black, bottom stripe white", ... ]

Then we add the accessibilityLabel(0 modifier to the flag images. To do that you need:

1. Use countries[number] to get the name of the country for the current flag.

2. Use that name as the key for labels.

3. Provide a string to use as a default if somehow the country name doesn’t exist in the dictionary. (This should never happen, but there’s no harm being safe!)

Putting all that together, put this modifier directly below the rest of the modifiers for the flag

images:

.accessibilityLabel(labels[countries[number], default: "Unknown flag"])

## Fixing Word Scramble

In this app, we want to get rid of the problem with voice over when it reads the number of characters inside the circle, so we can use:

Section{

ForEach(usedWords, id: \.self) { word in

HStack{

// This line allows you to show the count of letters of the word in a circle

Image(systemName: "\(word.count).circle")

Text(word)

}

.accessibilityElement(children: .ignore)

.accessibilityLabel("\(word), \(word.count) letters")

}

}

With the previous code, we ignore the hole HStack components but we add a label with the word and the word count. Alternatively, we could breack that text up to have a hint as well as a label, like this:

Section{

ForEach(usedWords, id: \.self) { word in

HStack{

// This line allows you to show the count of letters of the word in a circle

Image(systemName: "\(word.count).circle")

Text(word)

}

.accessibilityElement(children: .ignore)

.accessibilityLabel(word)

.accessibilityHint("\(word.count) letters")

}

}

## Fixing Bookworm

Fr the Bookworm project, we will apply the following changes in the RatingView:

ForEach(1..<maximumRating + 1, id: \.**self**){ number **in**

image(for: number)

.foregroundColor(number > rating ? offColor : onColor)

.onTapGesture {

rating = number

}

.accessibilityLabel("\(number == 1 ? "1 star" : "\(number) stars")")

.accessibilityRemoveTraits(.isImage)

.accessibilityAddTraits(number > rating ? .isButton : [.isButton, .isSelected])

}

However, there is a second approach that works more efficiently for folks relying on VoiceOver and other tools;

ForEach(1..<maximumRating + 1, id: \.**self**){ number **in**

image(for: number)

.foregroundColor(number > rating ? offColor : onColor)

.onTapGesture {

rating = number

}

.accessibilityElement()

.accessibilityLabel(label)

.accessibilityValue(rating == 1 ? "1 star" : "\(rating) stars")

.accessibilityAdjustableAction { direction **in**

**switch** direction {

**case** .increment:

**if** rating < maximumRating { rating += 1 }

**case** .decrement:

**if** rating > 1 { rating -= 1 }

**default**:

**break**

}

}

}

That groups all its children together, applies the label “Rating”, but then adds a value based on the current stars. It also allows that rating value to be adjusted up or down using swipes, which is much better than trying to work through lots of individual images.

# Project 16 – Hot Prospects

In this project we’re going to build Hot Prospects, which is an app to track who you meet at conferences.

## Reading custom values from the environment with @EnvironmentObject

You’ve seen how **@State** is used to work with state that is local to a single view, and how **@ObservedObject** lets us pass one object from view to view so we can share it. Well, **@EnvironmentObject** takes that one step further: we can place an object into the environment so that any child view can automatically have access to it.

With @EnvironmentObject we can put an object in a view, lets say view A, and a view E can read it even when the view A needs to pass through view B, C and D to reach view E.

Environment objects use the same ObservableObject protocol you’ve already learned, and SwiftUI will automatically make sure all views that share the same environment object get updated when it changes.

The property wrapper @EnvironmentObject will try to find an instance of user in the environment, if it cannot find it, the app will crash.

@MainActor **class** User: ObservableObject {

@Published **var** name = "Corey Taylor"

}

**struct** EditView: View {

@EnvironmentObject **var** user: User

**var** body: **some** View {

TextField("Name", text: $user.name)

}

}

**struct** DisplayView: View {

@EnvironmentObject **var** user: User

**var** body: **some** View{

Text(user.name)

}

}

**struct** \_1\_ReadCustomValues: View {

@StateObject **private** **var** user = User()

**var** body: **some** View {

VStack {

EditView().environmentObject(user)

DisplayView().environmentObject(user)

}

}

}

If we update the text in the EditView, it will be also updated in the DisplayView.

We can remove the .environmentObject modifier and add it to the VStack like this:

**var** body: **some** View {

VStack {

EditView()

DisplayView()

}.environmentObject(user)

}

**Tip:** Given that we are explicitly sharing our **User** instance with other views, I would personally be inclined to remove the **private** access control because it’s not accurate.

Now, you might wonder how SwiftUI makes the connection  
between **.environmentObject(user)** and **@EnvironmentObject var user: User** – how does it know to place that object into the correct property?

Well, you’ve seen how dictionaries let us use one type for the key and another for the value. The environment effectively lets us use data types themselves for the key, and instances of the type as the value. This is a bit mind bending at first, but imagine it like this: the keys are things like **Int**, **String**, and **Bool**, with the values being things like 5, “Hello”, and true, which means we can say “give me that Int” and we’d get back 5.

## Creating tabs with TabView and tabItem()

TabView creates a button stript across the bottom of the screen, where tapping each button shows a different view.

The tabItem() modifier lets you customize the way the view is shown in the tab bar, providing an image and some text to show next to it like this:

**var** body: **some** View {

TabView {

Text("Tab 1")

.tabItem {

Label("One", systemImage: "star")

}

Text("Tab 2")

.tabItem {

Label("Two", systemImage: "circle")

}

}

}

As well as letting the user switch views by tapping on their tab item, SwiftUI also allows us to control the current view programmatically using state. For this, we need:

1. Create an **@State** property to track the tab that is currently showing.  
2. Modify that property to a new value whenever we want to jump to a different tab.

3. Pass that as a binding into the **TabView**, so it will be tracked automatically.  
4. Tell SwiftUI which tab should be shown for each value of that property.

When we say **selectedTab = "Two"** how does SwiftUI know which tab that represents? we can attach a unique identifier to each view, and use *that* for the selected tab. These identifiers are called tags, and are attached using the **tag()** modifier.

**struct** \_2\_TabView: View {

// Keep track of the current tab

@State **private** **var** selectedTab = "One"

**var** body: **some** View {

TabView(selection: $selectedTab) {

Text("Tab 1")

.onTapGesture {

selectedTab = "Two"

}

.tabItem {

Label("One", systemImage: "star")

}

.tag("One")

Text("Tab 2")

.tabItem {

Label("Two", systemImage: "circle")

}

.tag("Two")

}

}

}

It’s common to want to use **NavigationView** and **TabView** at the same time, but you should be careful: **TabView** should be the parent view, with the tabs inside it having a **NavigationView** as necessary, rather than the other way around.

## Manually publishing ObservableObject changes

Classes that conform to the **ObservableObject** protocol can use SwiftUI’s **@Published** property wrapper to automatically announce changes to properties, so that any views using the object get their **body** property reinvoked and stay in sync with their data. That works really well a lot of the time, but sometimes you want a little more control and SwiftUI’s solution is called **objectWillChange**.

Every class that conforms to **ObservableObject** automatically gains a property called **objectWillChange**. This is a *publisher*, which means it does the same job as the **@Published** property wrapper: it notifies any views that are observing that object that something important has changed.

To demonstrate this we’re going to build an **ObservableObject** class that updates itself 10 times. We’re going to use a method called **DispatchQueue.main.asyncAfter()**, which lets us run an attached closure after a delay of our choosing, which means we can say “do this work after 1 second” rather than “do this work now.”

In this test case, we’re going to use **asyncAfter()** inside a loop from 1 through 10, so we increment an integer 10 values. That integer will be wrapped using **@Published** so change announcements are sent out to any views that are watching it.

@MainActor **class** DelayedUpdater: ObservableObject {

@Published **var** value = 0

**init**() {

**for** i **in** 1...10 {

DispatchQueue.main.asyncAfter(deadline: .now() + Double(i)) {

**self**.value += 1

}

}

}

}

**struct** \_3\_ManualPublish: View {

@ObservedObject **var** updater = DelayedUpdater()

**var** body: **some** View {

Text("Value is \(updater.value)")

}

}

If you remove the @Published property wrapper the UI no longer changes, because the UI is not refreshed as no change notifications are being sent out.

We can fix this by sending the change notifications manually using the **objectWillChange** property

@MainActor **class** DelayedUpdater: ObservableObject {

**var** value = 0 {

**willSet** {

objectWillChange.send()

}

}

**init**() {

**for** i **in** 1...10 {

DispatchQueue.main.asyncAfter(deadline: .now() + Double(i)) {

**self**.value += 1

}

}

}

}

**struct** \_3\_ManualPublish: View {

@ObservedObject **var** updater = DelayedUpdater()

**var** body: **some** View {

Text("Value is \(updater.value)")

}

}

With this we have the same behavior, the UI will count to 10 except this time we have the opportunity to add extra functionality inside the willSet observer.

## Understanding Swift’s Result type

Swift provides a special type called **Result**, that allows us to encapsulate either a successful value or some kind of error type, all in a single piece of data.

In the following example, we are using Result in a method that downloads an array of data readings from a server. We are using Result through the API Task.

**struct** \_4\_Result: View {

@State **private** **var** output = ""

**var** body: **some** View {

Text(output)

.task {

**await** fetchReadings()

}

}

**func** fetchReadings() **async** {

**let** fetchTask = Task { () -> String **in**

**let** url = URL(string: "https://hws.dev/readings.json")!

**let** (data, \_) = **try** **await** URLSession.shared.data(from: url)

**let** readings = **try** JSONDecoder().decode([Double].**self**, from: data)

**return** "Found \(readings.count) readings"

}

}

}

The Task object has been given the name fetchTask, it can be passed around or be cancelled. The task closure returns a value that gets stored in the Task instance.

**Task** might have thrown an error if the network fetch failed, or if the data decoding failed, and that’s where **Result** comes in: the result of our task might a string saying “Found 10000 readings”, but it might also contain an error. To read the result from a **Task**, read its **result** property

**let** result = **await** fetchTask.result

We haven’t used to use **try** to read the **Result** out? That’s because **Result** holds it inside itself

You can read the successful value directly from the **Result**

do {

output = try result.get()

} catch {

output = "Error: \(error.localizedDescription)"

}

Or this:

switch result {

case .success(let str):

output = str

case .failure(let error):

output = "Error: \(error.localizedDescription)"

}

## Controlling image interpolation in SwiftUI

Image interpolation is what happens when you make a SwiftUI Image view to stretch its content to be larger than its original size. there is one place where image interpolation causes a problem, and that’s when you’re dealing with precise pixels.

SwiftUI gives us the interpolation() modifier that lets us control how pixel blending is applied. There are multiple levels to this, but realistically we only care about one: .none. This turns off image interpolation entirely, so rather than blending pixels they just get scaled up with sharp edges.

**struct** \_5\_Image\_Interplation: View {

**var** body: **some** View {

Image("example")

.interpolation(.none)

.resizable()

.scaledToFit()

.frame(maxHeight:.infinity )

.background(.black)

.ignoresSafeArea()

}

}

## Creating context menus

SwiftUI lets us attach context menus to objects to provide an extra functionality, all done using the **contextMenu()** modifier. You can pass this a selection of buttons and they’ll be shown in order, so we could build a simple context menu to control a view’s background color like this:

**struct** \_6\_Context\_Menus: View {

@State **private** **var** backgroundColor = Color.red

**var** body: **some** View {

VStack {

Text("Hello, World!")

.padding()

.background(backgroundColor)

Text("Change Color")

.padding()

.contextMenu {

Button("Red") {

backgroundColor = .red

}

Button("Green") {

backgroundColor = .green

}

Button("Blue") {

backgroundColor = .blue

}

}

}

}

}

Just like **TabView**, each item in a context menu can have text and an image attached to it using a **Label** view.

To keep user interfaces looking somewhat uniform across apps, iOS renders each image as a solid color where the opacity is preserved. This makes many pictures useless: if you had three photos of three different dogs, all three would be rendered as a plain black square because all the color got removed.

Button(role: .destructive){

backgroundColor = .red

} label: {

Label("Red", systemImage: "checkmark.circle.fill")

.foregroundColor(.red)

}

In the previous code, we use line art icons and the role: .destructive to be able to use the foregroundColor.

## Adding custom row swipe actions to a List

The “Swipe to delete” functionality allows multiple buttons, often on either side of the row. We get this full functionality using the swipeActions() modifier. By default buttons will be placed on the right edge of the row, and won’t have any color.

You can customize edge where your buttons are placed by providing an **edge** parameter to your **swipeActions()** modifier, and you can customize the color of your buttons either by adding a **tint()** modifier to them with a color of your choosing, or by attaching a button role.

**struct** \_7\_Custom\_Row\_Swipe: View {

**var** body: **some** View {

List {

Text("Taylor Swift")

.swipeActions {

Button(role: .destructive) {

print("Hi")

} label: {

Label("Send message", systemImage: "message")

}

}

.swipeActions(edge: .leading){

Button{

print("Hi")

} label: {

Label("Pin", systemImage: "pin")

}

.tint(.orange)

}

}

}

}

## Scheduling local notifications

UserNotifications lets us create notifications to the user that can be shown on the lock screen. There are two types: local notifications are ones we schedule locally, and remote notifications (commonly called push notifications) are sent from a server somewhere.

Remote notifications require a server to work, because you send your message to Apple’s push notification service (APNS), which then forwards it to users.

Using local notifications requires asking the user for permission, then actually registering the notification we want to show. We’ll place each of those actions into separate buttons inside a **VStack**

When we tell iOS what kinds of notifications we want, it will show a prompt to the user so they have the final say on what our app can do. When they make their choice, a closure we provide will get called and tell us whether the request was successful or not.

Even though notifications might seem simple, Apple breaks them down into three parts to give it maximum flexibility:

* The content is what should be shown, and can be a title, subtitle, sound, image, and so on.
* The trigger determines when the notification should be shown, and can be a number of seconds from now, a date and time in the future, or a location.
* The request combines the content and trigger, but also adds a unique identifier so you can edit or remove specific alerts later on. If you don’t want to edit or remove stuff, use **UUID().uuidString** to get a random identifier.

**struct** \_8\_Local\_Notifications: View {

**var** body: **some** View {

VStack {

Button("Request Permission") {

UNUserNotificationCenter.current()

.requestAuthorization(options: [.alert, .badge, .sound]) { success, error **in**

**if** success {

print("All set!")

} **else** **if** **let** error = error {

print(error.localizedDescription)

}

}

}

Button("Schedule Notification") {

**let** content = UNMutableNotificationContent()

content.title = "Feed the cat"

content.subtitle = "It looks hungry"

content.sound = UNNotificationSound.default

// show this notification five seconds from now

**let** trigger = UNTimeIntervalNotificationTrigger(timeInterval: 5, repeats: **false**)

// choose a random identifier

**let** request = UNNotificationRequest(identifier:

UUID().uuidString, content: content, trigger: trigger)

// add our notification request

UNUserNotificationCenter.current().add(request)

}

}

}

}

The second button is using a UNTimeIntervalNotificationTrigger which lets us request a notification to be shown in a certain number of seconds from now. This one can be visible when the screen is locked (press Cmd + L).

## Adding Swift package dependencies in Xcode

Xcode comes with a dependency manager built in, called Swift Package Manager (SPM). You can tell Xcode the URL of some code that’s stored online, and it will download it for you.

To add a depedency, open File menu >Add Package Dependencies.

You can enter a URL for the repository of the dependency you want to import.

The SemVer patterns specify three numbers for the version, for example, if the version is 1.5.3, 1 is the major version, 5 is the minor number and 3 is the patch number. Developers should change these numbers when:

* Change the patch number when fixing a bug as long as it doesn’t break any APIs or add fetures.
* Change the minor number when they added features that don’t break any APIs.
* Change the major number when they do break APIs.

Import the dependency like any other package from Swift.

The array we get with the random numbers from the array, can be converted into string using the map() method, by applying a function to each element. In our case, we want to initialize a new string from each integer, so we can use String.init as the function we want to call.

**import** SwiftUI

**import** SamplePackage

**struct** \_9\_Swift\_Packages: View {

**let** possibleNumbers = Array(1...60)

**var** results: String {

// Get 7 random numbers from the array

**let** selected = possibleNumbers.random(7).sorted()

// Convert the array into String

**let** strings = selected.map(String.init)

**return** strings.joined(separator: ", ")

}

**var** body: **some** View {

Text(results)

}

}

## Building our tab bar

The main project will display a tab bar with 4 views:

**struct** ContentView: View {

**var** body: **some** View {

TabView {

ProspectView(filter: .none)

.tabItem {

Label("Everyone", systemImage: "person.3")

}

ProspectView(filter: .contacted)

.tabItem {

Label("Contacted", systemImage: "checkmark.circle")

}

ProspectView(filter: .uncontacted)

.tabItem {

Label("Uncontacted", systemImage: "questionmark.diamond")

}

MeView()

.tabItem {

Label("Me", systemImage: "person.crop.square")

}

}

}

}

Three of the tabs will create an instance of ProspectView:

**struct** ProspectView: View {

// Filter to differentiate the views

**enum** FilterType {

**case** none, contacted, uncontacted

}

**let** filter: FilterType

**var** title: String {

**switch** filter {

**case** .none:

**return** "Everyone"

**case** .contacted:

**return** "Contacted people"

**case** .uncontacted:

**return** "Uncontacted people"

}

}

**var** body: **some** View {

NavigationView {

Text("Hello, World!")

.navigationTitle(title)

}

}

}

## Sharing data across tabs using @EnvironmentObject

Any view can send objects into the environment, then any child view can read those objects back out from the environment at a later date. If one view changes the object all other views automatically get updated.

Create a Swift file for a class Prospect:

**import** SwiftUI

**class** Prospect: Identifiable, Codable {

**var** id = UUID()

**var** name = "Anonymous"

**var** emailAddress = ""

**var** isContacted = **false**

}

This is a class instead of a struct, because it allows us to change instances of the class directly and have it updated in all other views at the same time.

When you need to share data across multiple views, the SwfitUI’s environment uses the same ObservableObject protocol we’ve been using with the @StateObject property wrapper. This means we can mark properties that should be announced using the @Published property wrapper.

In the Prospect class, we add the following class:

@MainActor class Prospects: ObservableObject {

@Published var people: [Prospect]

init() {

self.people = []

}

}

In the ContentView, we add the following property:

@StateObject **var** prospects = Prospects()

Then we need to post that property into the SwiftUI environment, so that all child views can access it. Because tabs are considered children of the tab view they are inside, if we add it to the environment for the **TabView** then all our **ProspectsView** instances will get that object.

**struct** ContentView: View {

@StateObject **var** prospects = Prospects()

**var** body: **some** View {

TabView {

ProspectView(filter: .none)

.tabItem {

Label("Everyone", systemImage: "person.3")

}

ProspectView(filter: .contacted)

.tabItem {

Label("Contacted", systemImage: "checkmark.circle")

}

ProspectView(filter: .uncontacted)

.tabItem {

Label("Uncontacted", systemImage: "questionmark.diamond")

}

MeView()

.tabItem {

Label("Me", systemImage: "person.crop.square")

}

}

.environmentObject(prospects)

}

}

And now we want all instances of **ProspectsView** to read that object back out of the environment when they are created. This uses a new **@EnvironmentObject** property wrapper that does all the work of finding the object, attaching it to a property, and keeping it up to date over time.

**struct** ProspectView: View {

@EnvironmentObject **var** prospects: Prospects

**Important:** When you use **@EnvironmentObject** you are explicitly telling SwiftUI that your object will exist in the environment by the time the view is created. If it isn’t present, your app will crash immediately – be careful, and treat it like an implicitly unwrapped optional

The ProspectView will look like this:

**struct** ProspectView: View {

@EnvironmentObject **var** prospects: Prospects

// Filter to differentiate the views

**enum** FilterType {

**case** none, contacted, uncontacted

}

**let** filter: FilterType

**var** title: String {

**switch** filter {

**case** .none:

**return** "Everyone"

**case** .contacted:

**return** "Contacted people"

**case** .uncontacted:

**return** "Uncontacted people"

}

}

**var** body: **some** View {

NavigationView {

Text("People: \(prospects.people.count)")

.navigationTitle(title)

.toolbar {

Button {

**let** prospect = Prospect()

prospect.name = "Joe Jordinson"

prospect.emailAddress = "joeyjordinson@slpk.com"

prospects.people.append(prospect)

} label: {

Label("Scan", systemImage: "qrcode.viewfinder")

}

}

}

}

}

## Dynamically filtering a SwiftUI List

We can use the FilterType property to set the contents of a List. The easiest way to do this is using Swift’s **filter()** method. This runs every element in a sequence through a test you provide as a closure, and any elements that return true from the test are sent back as part of a new array. Our **ProspectsView** already has a **prospects** property being passed in with an array of people inside it, so we can either return all people, all contacted people, or all uncontacted people.

Add the following property to the ProspectView:

**var** filteredProspects: [Prospect] {

**switch** filter {

**case** .none:

**return** prospects.people

**case** .contacted:

**return** prospects.people.filter { $0.isContacted }

**case** .uncontacted:

**return** prospects.people.filter { !$0.isContacted }

}

}

When **filter()** runs, it passes every element in the **people** array through our test. So, **$0.isContacted** means “does the current element have its **isContacted** property set to true?” All items that passed the test will be added to a new array and sent back from filteredResults. This is a computed property that we can use to fill the list.

Now, the body of the ProspectsView will look like this:

**var** body: **some** View {

NavigationView {

List {

ForEach(filteredProspects) { prospect **in**

VStack(alignment: .leading) {

Text(prospect.name)

.font(.headline)

Text(prospect.emailAddress)

.foregroundColor(.secondary)

}

}

}

.navigationTitle(title)

.toolbar {

Button {

**let** prospect = Prospect()

prospect.name = "Paul Hudson"

prospect.emailAddress = "paul@hackingwithswift.com"

prospects.people.append(prospect)

} label: {

Label("Scan", systemImage: "qrcode.viewfinder")

}

}

}

}

When we added an @EnvironmentObject property to ProspectsView, we also asked SwiftUI to reinvoke the body property whenever that property changes. So, whenever we insert a new person into the people array its @Published property wrapper will announce the update to all views that are watching it, and SwiftUI will reinvoke the body property of ProspectsView. That in turn will calculate our computed property again, so the List will change.

## Generating and scaling up a QR code

Core Image lets us generate a QR code from any input string. But, there is a problem: the image is very small because it’s only as big as the pixels required to show its data. To make the image bigger and look good, we need to adjust SwiftUI’s image interpolation.

In the MeView, we are going to use the modifier textContentType() for the text fields to tell iOS what kind of information we’re asking the user for. This should allow iOS to provide autocomplete data.

We use the name and email address field to generate a QA core

**import** CoreImage.CIFilterBuiltins

**struct** MeView: View {

@State **private** **var** name = "Anonymous"

@State **private** **var** emailAddress = "you@yoursite.com"

**let** context = CIContext()

**let** filter = CIFilter.qrCodeGenerator()

**var** body: **some** View {

NavigationView {

Form {

TextField("Name", text: $name)

.textContentType(.name)

.font(.title)

TextField("Email address", text: $emailAddress)

.textContentType(.emailAddress)

.font(.title)

Image(uiImage: generateQRCode(from: "\(name)\n\(emailAddress)"))

.interpolation(.none)

.resizable()

.scaledToFit()

.frame(width: 200, height: 200)

}

.navigationTitle("Your code")

}

}

**func** generateQRCode(from string: String) -> UIImage{

filter.message = Data(string.utf8)

**if** **let** outputImage = filter.outputImage {

**if** **let** cgimg = context.createCGImage(outputImage, from: outputImage.extent) {

**return** UIImage(cgImage: cgimg)

}

}

**return** UIImage(systemName: "xmark.circle") ?? UIImage()

}

}

You need two properties to store an active Core Image context and an instance of Core Image’s QR code generator filter. making the QR code itself. If you remember, working with Core Image filters requires us to provide some input data, then convert the output CIImage into a CGImage, then that CGImage into a UIImage.

## Scanning QR codes with SwiftUI

Scanning a QR code can be done by Apple’s AVFoundation library, but this doesn’t integrate terribly smoothly. For the example, we will use a package called CodeScanner.

1. Go to File > Swift Packages > Add Package Dependency.  
2. Enter **https://github.com/twostraws/CodeScanner** as the package repository URL.  
3. For the version rules, leave “Up to Next Major” selected, which means you’ll get any bug

fixes and additional features but *not* any breaking changes. 4. Press Finish to import the finished package into your project.

We will import the CodeScanner in the ProspectView and use it for the Scan button.

All the code will be implemented in the ProspectView which will have a handleScan method to read the results from scanning the QR code.

**import** SwiftUI

**import** CodeScanner

**struct** ProspectView: View {

@EnvironmentObject **var** prospects: Prospects

@State **private** **var** isShowingScanner = **false**

// Filter to differentiate the views

**enum** FilterType {

**case** none, contacted, uncontacted

}

**let** filter: FilterType

**var** title: String {

**switch** filter {

**case** .none:

**return** "Everyone"

**case** .contacted:

**return** "Contacted people"

**case** .uncontacted:

**return** "Uncontacted people"

}

}

**var** filteredProspects: [Prospect] {

**switch** filter {

**case** .none:

**return** prospects.people

**case** .contacted:

**return** prospects.people.filter { $0.isContacted }

**case** .uncontacted:

**return** prospects.people.filter { !$0.isContacted }

}

}

**var** body: **some** View {

NavigationView {

List {

ForEach(filteredProspects) { prospect **in**

VStack(alignment: .leading) {

Text(prospect.name)

.font(.headline)

Text(prospect.emailAddress)

.foregroundColor(.secondary)

}

}

}

.navigationTitle(title)

.toolbar {

Button {

isShowingScanner = **true**

} label: {

Label("Scan", systemImage: "qrcode.viewfinder")

}

}

.sheet(isPresented: $isShowingScanner){

CodeScannerView(codeTypes: [.qr], simulatedData: "Corey Taylor\nctaylor@hackingwithswift.com", completion: handleScan)

}

}

}

**func** handleScan(result: Result<ScanResult, ScanError>) {

isShowingScanner = **false**

**switch** result {

**case** .success(**let** result):

**let** details = result.string.components(separatedBy: "\n")

**guard** details.count == 2 **else** { **return** }

**let** person = Prospect()

person.name = details[0]

person.emailAddress = details[1]

prospects.people.append(person)

**case** .failure(**let** error):

print("Scanning failed: \(error.localizedDescription)")

}

}

}

The Scan button will use a variable isShowingScanner to validate if the app must show a sheet with the CodeScannerView. This view will read the qr code and call the handleScan method.

## Adding options with Swipe Actions

A way to move people between the Contacted and Uncontacted tabs is to add a swipe action to the VStack in the ProspectsView.

First, add the following swipeAction to the VStack:

.swipeActions{

**if** prospect.isContacted {

Button {

prospect.isContacted.toggle()

} label: {

Label("Mark Uncontacted", systemImage: "person.crop.circle.badge.xmark")

}

.tint(.blue)

} **else** {

Button {

prospect.isContacted.toggle()

} label: {

Label("Mark Contacted", systemImage: "person.crop.circle.fill.badge.checkmark")

}

.tint(.green)

}

}

As the people array is marked with @Published, if we add or remove items from the array a change notification will be sent out. However, if we quietly change an item inside the array then SwiftUI won’t detect that change, and no views will be refreshed.

To fix this, we need to tell SwiftUI that something important has changed, we will call this method in the Prospects class:

@MainActor **class** Prospects: ObservableObject {

@Published **var** people: [Prospect]

**init**() {

**self**.people = []

}

**func** toggle(\_ prospect: Prospect){

objectWillChange.send()

prospect.isContacted.toggle()

}

}

It is important to note that objectWillChange.send() should be called before changing the property to ensure SwiftUI gets its animations correct.

Now you can replace the prospect.isContacted.toggle() action with this:

prospects.toggle(prospect)

There’s a specific access control option called **fileprivate**, which means “this property can only be used by code inside the current file.” So, modify the isContacted booelan property in Prospect class to this:

// Use fileprivate so it can be read from anywhere but only written from the current file

**fileprivate**(**set**) **var** isContacted = **false**

## Saving and loading data with UserDefaults

In this part we will make the Prospects initializer be able to load data from UserDefaults, then write it back when the data changes.

The Prospects class uses the @Published property wrapper, the people arra inside conforms to Codable so we just need to add some small changes:

1. Updating the **Prospects** initializer so that it loads its data from **UserDefaults** where

possible.

2. Adding a **save()** method to the same class, writing the current data *to* **UserDefaults**.

3. Calling **save()** when adding a prospect or toggling its **isContacted** property.

This is how the Prospect class looks now:

**class** Prospect: Identifiable, Codable {

**var** id = UUID()

**var** name = "Anonymous"

**var** emailAddress = ""

// Use fileprivate so it can be read from anywhere but only written from the current file

**fileprivate**(**set**) **var** isContacted = **false**

}

@MainActor **class** Prospects: ObservableObject {

@Published **private**(**set**) **var** people: [Prospect]

**let** saveKey = "SavedData"

**init**() {

// Load saved data from UserDefaults

**if** **let** data = UserDefaults.standard.data(forKey: saveKey) {

**if** **let** decoded = **try**? JSONDecoder().decode([Prospect].**self**, from: data) {

people = decoded

**return**

}

}

// No saved data!

people = []

}

**private** **func** save(){

**if** **let** encoded = **try**? JSONEncoder().encode(people) {

UserDefaults.standard.set(encoded, forKey: saveKey)

}

}

**func** add(\_ prospect: Prospect) {

people.append(prospect)

save()

}

**func** toggle(\_ prospect: Prospect) {

objectWillChange.send()

prospect.isContacted.toggle()

save()

}

}

We have added a saveKey to avoid typos or errors when saving or loading the data from UserDefaults.

In in the initializer we try to load the people array from UserDefaults.

We added a private save function that will save the values from the people array into the UserDefaults.

This previous function will be called from the add function, which previous to save the data, it will append the prospect to the people array.

So in the ProspectView class, in the handleScan method, we call the prospects.add(person) when the scanning has been successfully completed.

## Adding a context menu to an image

The goal here is to allow the user to save the QR Code based on the user’s name and email.

First, import the ImageSaver class from the InstaFilter project:

**import** UIKit

**class** ImageSaver: NSObject {

**var** successHandler: (() -> Void)?

**var** errorHandler: ((Error) -> Void)?

**func** writeToPhotoAlbum(image: UIImage){

UIImageWriteToSavedPhotosAlbum(image, **self**, **#selector**(saveCompleted), **nil**)

}

**@objc** **func** saveCompleted(\_ image: UIImage, didFinishSavingWithError error: Error?, contextInfo: UnsafeRawPointer){

// If there is an error, pass the error to the errorHandler

**if** **let** error = error {

errorHandler?(error)

} **else** {

successHandler?()

}

}

}

In the MeView.swift, add a contextMenu for the Image that displays the qrCode. In that contextMenu, we will have a button that will use image saver to save the file in the device.

Then, we will create a qrCode state var that will store the code we generate:

We will tell our image to render directly from the cached qrImage property, then call the generateQRCode() when the view appears and whenever either name or email address changes. For this, we added the updateCode method.

In the Image view, now we have Image(uiImage: qrCode) and we added the onAppear and onChange modifiers. This will ensure the QR code is updated as soon as the view is shown or whenever the name or email address get changed.

At the end, the MeView should look like this:

**struct** MeView: View {

@State **private** **var** name = "Anonymous"

@State **private** **var** emailAddress = "you@yoursite.com"

@State **private** **var** qrCode = UIImage()

**let** context = CIContext()

**let** filter = CIFilter.qrCodeGenerator()

**var** body: **some** View {

NavigationView {

Form {

TextField("Name", text: $name)

.textContentType(.name)

.font(.title)

TextField("Email address", text: $emailAddress)

.textContentType(.emailAddress)

.font(.title)

Image(uiImage: qrCode)

.interpolation(.none)

.resizable()

.scaledToFit()

.frame(width: 200, height: 200)

.contextMenu {

Button{

**let** imageSaver = ImageSaver()

imageSaver.writeToPhotoAlbum(image: qrCode)

} label: {

Label("Save to Photos", systemImage: "square.and.arrow.down")

}

}

}

.navigationTitle("Your code")

.onAppear(perform: updatedCode)

.onChange(of: [name, emailAddress]) { \_ **in**

updatedCode()

}

}

}

**func** updatedCode() {

qrCode = generateQRCode(from: "\(name)\n\(emailAddress)")

}

**func** generateQRCode(from string: String) -> UIImage{

filter.message = Data(string.utf8)

**if** **let** outputImage = filter.outputImage {

**if** **let** cgimg = context.createCGImage(outputImage, from: outputImage.extent) {

**return** UIImage(cgImage: cgimg)

}

}

**return** UIImage(systemName: "xmark.circle") ?? UIImage()

}

}

Also, we have to add a permission request string for the Privacy – Photo Library Additions Usage Description.

## Posting notifications to the lock screen

In this part, we will add another button to our list swipe actions to let the user be remined to contact a particular person. This will use iOS’s UserNotifications framework.

One option is to call **requestAuthorization()** *every time we want to post a notification.*

There is another way: we can request the current authorization settings and use that to determine whether we should schedule a notification or request permission.

The reason it’s helpful to use *this* approach rather than just requesting permission repeatedly, is that the settings object handed back to us includes properties such as **alertSetting** to check whether we can show an alert or not – the user might have restricted this so all we can do is display a numbered badge on our icon.

We’re going to call **getNotificationSettings()** to read whether notifications are currently

allowed. If they are, we’ll show a notification. If they *aren’t*, we’ll request permissions, and if

*that* comes back successfully then we’ll also show a notification.

Start by adding the import in the ProspectsView.swift:

**import** UserNotifications

Add the following method to the ProspectsView struct:

**func** addNotification(for prospect: Prospect){

**let** center = UNUserNotificationCenter.current()

**let** addRequest = {

**let** content = UNMutableNotificationContent()

content.title = "Contact \(prospect.name)"

content.subtitle = prospect.emailAddress

content.sound = UNNotificationSound.default

**var** dateComponents = DateComponents()

dateComponents.hour = 9

// let trigger = UNCalendarNotificationTrigger(dateMatching: dateComponents, repeats: false)

// For local testing

**let** trigger = UNTimeIntervalNotificationTrigger(timeInterval: 5, repeats: **false**)

**let** request = UNNotificationRequest(identifier: UUID().uuidString, content: content, trigger: trigger)

center.add(request)

}

center.getNotificationSettings { settings **in**

**if** settings.authorizationStatus == .authorized {

addRequest()

} **else** {

center.requestAuthorization(options: [.alert, .badge, .sound]) { success, error **in**

**if** success {

addRequest()

}**else** {

print("D'oh!")

}

}

}

}

}

Important things to note:

* The UNCalendarNotificationTrigger lets us specify a custom DateComponents instance, which we have set an hour of 9, which means it will trigger the next time 9am comes about.
* We use getNotificationSettings() and requestAuthorization() together to make sure we only schedule notifications when allowed.
* The addRequest closure is called when we have permission already or if we ask and have been granted permission with the requestAuthorization.

Finally, we add an extra button to our swipe actions below the “Mark Contacted” button:

} **else** {

Button {

prospects.toggle(prospect)

} label: {

Label("Mark Contacted", systemImage: "person.crop.circle.fill.badge.checkmark")

}

.tint(.green)

Button {

addNotification(for: prospect)

} label: {

Label("Remind Me", systemImage: "bell")

}

.tint(.orange)

}

# Project 17 – Flashzilla

## How to use gestures in SwiftUI

You can use lots of gestures for working with views. The most common is the onTapGesture(). This one can receive a count parameter to tmake them handle double taps, triple taps, and more:

Text("Hello, World!")

.onTapGesture(count: 2) {

print("Double tapped!")

}

You can also have a longPressGesture, with the optional parameter of minimum duration so your action closure only triggers after a specific number of seconds you have passed.

Text"Hello, World!")

.onLongPressGesture(minimumDuration: 2){

print("Long pressed")

}

You can even add a second closure that triggers whenever the state of the gesture has changed.

Text(/\*@START\_MENU\_TOKEN@\*/"Hello, World!"/\*@END\_MENU\_TOKEN@\*/)

.onLongPressGesture(minimumDuration: 2){

print("Long pressed")

} onPressingChanged: {inProgress **in**

print("In progress: \(inProgress)!")

}

For more advanced gestures you should use the **gesture()** modifier with one of the gesture structs: **DragGesture**, **LongPressGesture**, **MagnificationGesture**, **RotationGesture**, and **TapGesture**. These all have special modifiers, usually **onEnded()** and often **onChanged()** too, and you can use them to take action when the gestures are in-flight (for **onChanged()**) or completed (for **onEnded()**).

The next is an example of the magnification gesture, so that pinching in and out scales the view up and down:

@State **private** **var** currentAmount = 0.0

@State **private** **var** finalAmount = 1.0

**var** body: **some** View {

Text(/\*@START\_MENU\_TOKEN@\*/"Hello, World!"/\*@END\_MENU\_TOKEN@\*/)

.scaleEffect(finalAmount + currentAmount)

.gesture(

MagnificationGesture()

.onChanged { amount **in**

currentAmount = amount - 1

}

.onEnded { amount **in**

finalAmount += currentAmount

currentAmount = 0

}

)

}

You can also have a rotation gesture

@State **private** **var** currentAmount = Angle.zero

@State **private** **var** finalAmount = Angle.zero

**var** body: **some** View {

/\* Rotation Gesture \*/

Text("Hello, world!")

.rotationEffect(currentAmount + finalAmount)

.gesture(

RotationGesture()

.onChanged { angle **in**

currentAmount = angle

}

.onEnded { angle **in**

finalAmount += currentAmount

currentAmount = .zero

}

)

When we have two gestures that might be recognized at the same time, for example, a Text view inside a VStack, and both have an onTapGesture, SwiftUI will give the priority to the child. If you want to give the priority to the parent, you can use the modifier highPriorityGesture:

VStack {

Text("Testing onTapGesture")

.onTapGesture {

print("Text tapped!")

}

}

.highPriorityGesture(

TapGesture()

.onEnded{

print("VStack tapped!")

}

)

You can use alternatively the simultaneousGesture modifier if you want that both gestures trigger at the same time.

VStack {

Text("Hello, World!")

.onTapGesture {

print("Text tapped")

}

}

.simultaneousGesture(

TapGesture()

.onEnded { \_

in

print("VStack tapped")

}

Finally, you can create a sequence, where one gesture will only become active if another gesture has first succeeded. In the example, you can drag a circle around the screen but only if you long press on it first.

// how far the circle has been dragged

@State **private** **var** offset = CGSize.zero

// whether it is currently being dragged or not

@State **private** **var** isDragging = **false**

**var** body: **some** View {

// a drag gesture that updates offset and isDragging as it moves around

**let** dragGesture = DragGesture()

.onChanged { value **in** offset = value.translation }

.onEnded { \_ **in**

withAnimation {

offset = .zero

isDragging = **false**

}

}

// a long press gesture that enables isDragging

**let** pressGesture = LongPressGesture()

.onEnded { value **in**

withAnimation {

isDragging = **true**

}

}

// a combined gesture that forces the user to long press then drag

**let** combined = pressGesture.sequenced(before: dragGesture)

// a 64x64 circle that scales up when it's dragged, sets

// its offset to whatever we had back from the drag gesture, and

// uses our combined gesture

Circle()

.fill(.red)

.frame(width: 64, height: 64)

.scaleEffect(isDragging ? 1.5 : 1)

.offset(offset)

.gesture(combined)

}

## Making vibrations with UINotificationFeedbackGenerator and Core Haptics

SwiftUI doesn’t come withany haptic functionlity built in, but we can use UIKit and Core Haptics. “Haptics” involves small motors in the device to create sensations such as aps and vibrations.

Here is an example:

**var** body: **some** View {

Text(/\*@START\_MENU\_TOKEN@\*/"Hello, World!"/\*@END\_MENU\_TOKEN@\*/)

.onTapGesture(perform: simpleSuccess)

}

**func** simpleSuccess(){

**let** generator = UINotificationFeedbackGenerator()

generator.notificationOccurred(.success)

}

Apple provides a framework called Core Haptics. It let us create customizable haptics by combining taps, continuous vibrations, parameter curves and more.

**struct** \_2\_Vibrations: View {

@State **private** **var** engine: CHHapticEngine?

**var** body: **some** View {

Text("Hello, World!")

.onAppear(perform: prepareHaptics)

.onTapGesture(perform: complexSuccess)

//.onTapGesture(perform: simpleSuccess)

}

**func** prepareHaptics(){

**guard** CHHapticEngine.capabilitiesForHardware().supportsHaptics **else** { **return** }

**do** {

engine = **try** CHHapticEngine()

**try** engine?.start()

} **catch** {

print("There was an error creating the engine: \(error.localizedDescription)")

}

}

**func** complexSuccess(){

// make sure that the device supports haptics

**guard** CHHapticEngine.capabilitiesForHardware().supportsHaptics **else** { **return** }

**var** events = [CHHapticEvent]()

// create one intense, sharp tap

**let** intensity = CHHapticEventParameter(parameterID: .hapticIntensity, value: 1)

**let** sharpness = CHHapticEventParameter(parameterID: .hapticSharpness, value: 1)

**let** event = CHHapticEvent(eventType: .hapticTransient,

parameters: [intensity, sharpness], relativeTime: 0)

events.append(event)

// convert those events into a pattern and play it immediately

**do** {

**let** pattern = **try** CHHapticPattern(events: events, parameters: [])

**let** player = **try** engine?.makePlayer(with: pattern)

**try** player?.start(atTime: 0)

} **catch** {

print("Failed to play pattern: \(error.localizedDescription).")

}

}

}

In the example above, there are some things to note:

* We need to import CoreHaptics
* Create an instance of CHHapticEngine
* We can configure parameters that control how strong the haptic should be and how “sharp” it is.

## Disabling user interactivity with allowsHitTesting()

SwiftUI has an advanced hit testing algorithm that uses both the frame of a view and often also its contents. For example, if you add a tap gesture to a text view then all parts of the text view are tappable – you can’t tap through the text if you happen to press exactly where a space is. On the other hand, if you attach the same gesture to a circle then SwiftUI *will* ignore the transparent parts of the circle.

For example:

ZStack {

Rectangle()

.fill(Color.blue)

.frame(width: 300, height: 300)

.onTapGesture {

print("Rectangle tapped!")

}

Circle()

.fill(Color.red)

.frame(width: 300, height: 300)

.onTapGesture {

print("Circle tapped!")

}

}

With the previous code, when you tap inside the circle it will print “Circle tapped!”, but on the rectangle behind the circle prints “Rectangle tapped” – even though the circle actually has the same frame as the rectangle.

If we use the allowsHitTesting() modifier and set the parameter to false, the view is not considered tappable, in the example above, the view behind will receive the tap instead.

Circle()

.fill(Color.red)

.frame(width: 300, height: 300)

.onTapGesture {

print("Circle tapped!")

}

.allowsHitTesting(**false**)

Another useful modifier is the contentShape which lets us specify the tappable shape for something. By default, the tappable shape for a circle, is a circle of the same size, but you can specify a different shape. In the next example, if we use contentShape(Rectable()) on the Vstack, the whole area for the stack becomes tappable, including the spacer:

**func** showFiguretwo() -> **some** View {

VStack {

Text("Hello")

Spacer().frame(height: 100)

Text("World")

}

.contentShape(Rectangle())

.onTapGesture {

print("VStack tapped!")

}

}

## Triggering events repeatedly using a timer

iOS comes with a built-in **Timer** class that lets us run code on a regular basis. This uses a system of *publishers* that comes from an Apple framework called Combine.

The Timer class comes from the Apple’s core system library called Foundation. This class runs a function after a certain number of seconds but it can also run code repeatedly. Combine adds an extension to this so that timers can become *publishers*, which are things that announce when their value changes.

The code to create a timer publisher looks like this:

let timer = Timer.publish(every: 1, on: .main,

in: .common).autoconnect()

This code asks for the timer to fire every 1 second, it specifies the timer should run on the main thread, it also should run on the common run loop. It connects the timer immediately and assign the whole thing to the timer constant.

In the case of regular publishers like this one, we need to catch the announcements by hand using a new modifier called **onReceive()**. This accepts a publisher as its first parameter and a function to run as its second, and it will make sure that function is called whenever the publisher sends its change notification.

Text(/\*@START\_MENU\_TOKEN@\*/"Hello, World!"/\*@END\_MENU\_TOKEN@\*/)

.onReceive(timer) { time **in**

print("The time is now \(time)")

}

This will print the time every second until the timer is finally stopped.

The **timer** property we made is an autoconnected publisher, so we need to go to its *upstream publisher* to find the timer itself. From there we can connect to the timer publisher, and ask it to cancel itself.

Text("Hello, World!")

.onReceive(timer) { time **in**

**if** counter == 5 {

**timer.upstream.connect().cancel()**

} **else** {

print("The time is now \(time)")

}

counter += 1

}

There is another concept for timer: tolerance. This allows iOS to perform important energy optimization, because it can fire the timer at any point between its scheduled fire time and its scheduled fire time plus the tolerance you specify.

**let** timer = Timer.publish(every: 1, tolerance: 0.5, on: .main, in: .common).autoconnect()

## How to be notified when your SwiftUI app moves to the background

SwiftUI can detect when your app moves to the background and when it comes back to the foreground, and if you put those two together it allows us to make sure our app pauses and resumes work depending on whether the user can see it right now or not.

This is done usign three steps:

1. Adding a new property to watch an environment value called **scenePhase**.

2. Using **onChange()** to watch for the scene phase changing.

3. Responding to the new scene phase somehow.

Example:

**struct** \_5\_MovingToBackground: View {

@Environment(\.scenePhase) **var** scenePhase

**var** body: **some** View {

Text("Hello, World!")

.padding()

.onChange(of: scenePhase) { newPhase **in**

**if** newPhase == .active {

print("Active")

} **else** **if** newPhase == .inactive {

print("Inactive")

} **else** **if** newPhase == .background {

print("Background")

}

}

}

}

**Active scenes** are running right now, in iOS it means they are visible to the user. On MacOS an app’s window might be fully hidden by another app’s window, but it is still considered to be active.

**Inactive scenes** are running and might be visible to the user, but the user isn’t able to access them.

**Background scenes** are not visible to the user, they might be terminated at some point in the future.

## Supporting specific accessibility needs with SwiftUI

There are some settings that are provided throught the environment. This means SwiftUI automatically monitors them for changes and will reinvoke our body property whenever one of them changes.

One of the accessibility options is “Differentiate without color”, which is helpful for color blindness. When this setting is enabled, apps should try to make their UI clearer using shapes, icons and textures rather than colors.

The following code is an example of using this setting:

**struct** \_6\_SpecificAccessiblity: View {

@Environment(\.accessibilityDifferentiateWithoutColor) **var** differentiateWithoutColor

**var** body: **some** View {

HStack {

**if** differentiateWithoutColor {

Image(systemName: "checkmark.circle")

}

Text("Success")

}

.padding()

.background(differentiateWithoutColor ? .black : .green)

.foregroundColor(.white)

.clipShape(Capsule())

}

}

The line with the @Environment property will be either true or false, and in this case, we use a simple green background for the regular layout but if the property is true, we use a black background and add a checkmark instead.

Another option is Reduce Motion, which limits the amount of animation that causes movement on screen.

@Environment(\.accessibilityReduceMotion) **var** reduceMotion

@State **private** **var** scale = 1.0

Text("Hello, world!")

.scaleEffect(scale)

.onTapGesture {

withOptionalAnimation {

scale \*= 1.5

}

}

**func** withOptionalAnimation<Result>(\_ animation: Animation? = .default,

\_ body: () **throws** -> Result) **rethrows** -> Result {

**if** UIAccessibility.isReduceMotionEnabled {

**return** **try** body()

} **else** {

**return** **try** withAnimation(animation, body)

}

}

## Designing a single card view

To force landscape mode, go to your target options in the Info tab, open the disclosure indicator for the key “Supported interface orientations (iPhone)” and delete the portrait option so it leaves just the two landscape options.

Then, create a Card struct with the following proerties:

**struct** Card {

**let** prompt: String

**let** answer: String

**static** **let** example = Card(prompt: "Who played the 13th Doctor in Doctor Who?", answer: "Jodie Whittaker")

}

And create a CardView with the next code:

**struct** CardView: View {

@State **private** **var** isShowingAnswer = **false**

**let** card: Card

**var** body: **some** View {

ZStack {

RoundedRectangle(cornerRadius: 25, style: .continuous)

.fill(Color.white)

.shadow(radius: 10)

VStack{

Text(card.prompt)

.font(.largeTitle)

.foregroundColor(.black)

**if** isShowingAnswer {

Text(card.answer)

.font(.title)

.foregroundColor(.gray)

}

}

.padding(20)

.multilineTextAlignment(.center)

.onTapGesture {

isShowingAnswer.toggle()

}

}

.frame(width: 450, height: 250)

}

}

With this code we have created a Card that shows the question or prompt and the answer depending on the value of the isShowingAnswer. The Rectangle has a shadow to differentiate the card with the background.

## Building a stack of cards

In this part, we will create a stack of 10 cards using the example values. Adding the following property to the CardView view:

@State **private** **var** cards = [Card](repeating: Card.example, count: 10)

Then we will add an extension to the ContentView.swift, outside the ContentView struct that pushes views down by 10 points for each place they are in the array.

Then, replace the current body property in ContentView to display the cards using the stacked extension property.

And finally add a background to the first ZStack:

**struct** ContentView: View {

@State **private** **var** cards = [Card](repeating: Card.example, count: 10)

**var** body: **some** View {

ZStack {

Image("white-background")

.resizable()

.ignoresSafeArea()

VStack {

ZStack {

ForEach(0..<cards.count, id: \.**self**) { index **in**

CardView(card: cards[index])

.stacked(at: index, in: cards.count)

}

}

}

}

}

}

**extension** View {

**func** stacked(at position: Int, in total: Int) -> **some** View {

**let** offset = Double(total - position)

**return** **self**.offset(x: 0, y: offset \* 10)

}

}

## Moving views with DragGesture and offset()

SwiftUI lets us attach custom gestures to any view, then use the values created by those gestures to manipulate the rest of our views. We willl use the DragGesture to CardView so it can be moved around, and we’ll also use the values generated by that gesture to control the opacity and rotation of the view.

In the CardView we will make several changes:

* + - 1. We will add the offset property to track how far the user has dragged
      2. We add 3 modifiers to CardView, the order matters. The rotationEffect to describe how the card will rotate and using 1/5th of the drag amount. The offset will contain how far the user dragged the card and the opacity to fade out as it’s dragged further away.
      3. The drag gesture will update the offset as the user drags the card around. When the gesture has ended, if the user has moved the card more than 100 point, we remove the card, if not, we set offset back to 0.
      4. The removal is a closure in CardView, to let the parent (in this case ContentView) to send the logic to remove the card.

**struct** CardView: View {

@State **private** **var** isShowingAnswer = **false**

@State **private** **var** offset = CGSize.zero

**let** card: Card

**var** removal: (() -> Void )? = **nil**

**var** body: **some** View {

ZStack {

RoundedRectangle(cornerRadius: 25, style: .continuous)

.fill(Color.white)

.shadow(radius: 10)

VStack{

Text(card.prompt)

.font(.largeTitle)

.foregroundColor(.black)

**if** isShowingAnswer {

Text(card.answer)

.font(.title)

.foregroundColor(.gray)

}

}

.padding(20)

.multilineTextAlignment(.center)

.onTapGesture {

isShowingAnswer.toggle()

}

}

.frame(width: 450, height: 250)

.rotationEffect(.degrees(Double(offset.width / 5)))

.offset(x: offset.width \* 5, y: 0)

.opacity(2 - Double(abs(offset.width / 50)))

.gesture(

DragGesture()

.onChanged {gesture **in**

offset = gesture.translation

}

.onEnded { \_ **in**

**if** abs(offset.width) > 100 {

// Remove card

removal?()

} **else** {

offset = .zero

}

}

)

}

}

In the ContentView, we will add the function we will send for removing the card. And also, we add it to the trailing closure when we create the CardViews:

**struct** ContentView: View {

@State **private** **var** cards = [Card](repeating: Card.example, count: 10)

**var** body: **some** View {

ZStack {

Image("white-background")

.resizable()

.ignoresSafeArea()

VStack {

ZStack {

ForEach(0..<cards.count, id: \.**self**) { index **in**

CardView(card: cards[index]){

withAnimation(){

removeCard(at: index)

}

}

.stacked(at: index, in: cards.count)

}

}

}

}

}

**func** removeCard(at index: Int){

cards.remove(at: index)

}

}

## Coloring views as we swipe

Users can swipe the cards left or right to mark them as guessed correctly or not. We will make swipping right good (the use has guessed the answer correctly) and swipping left bad (answer is wrong).

For phones with default settings, we’ll make the cards become colored green or red before fading away, if the user enabled the Differentiate Without Color setting, we’ll leave the cards as white and instead show some extra UI over the brackground.

For the RoundedRectangle shape that shows the card, we will apply some changes:

First, we’ll add a background with the same rounded rectangle shape but in green or red depending on the gesture movement. This goes after the shadow modifier for the RoundedRectanble.

Then, add an opacity using 1 minus 1/50th of the gesture width

For the people with red/green blindness we will add an environment property to track whether we should be using color for this purpose or not.

In CardView.swift:

struct CardView: View {

@Environment(\.accessibilityDifferentiateWithoutColor) var differentiateWithoutColor

@State **private** **var** isShowingAnswer = **false**

@State **private** **var** offset = CGSize.zero

**let** card: Card

**var** removal: (() -> Void )? = **nil**

**var** body: **some** View {

ZStack {

RoundedRectangle(cornerRadius: 25, style: .continuous)

.fill(

differentiateWithoutColor

? .white

: .white

.opacity(1 - Double(abs(offset.width / 50)))

)

.background(

differentiateWithoutColor

? nil

: RoundedRectangle(cornerRadius: 25, style: .continuous)

.fill(offset.width > 0 ? .green : .red)

)

.shadow(radius: 10)

VStack{

Text(card.prompt)

.font(.largeTitle)

.foregroundColor(.black)

**if** isShowingAnswer {

Text(card.answer)

.font(.title)

.foregroundColor(.gray)

}

}

.padding(20)

.multilineTextAlignment(.center)

.onTapGesture {

isShowingAnswer.toggle()

}

}

.frame(width: 450, height: 250)

.rotationEffect(.degrees(Double(offset.width / 5)))

.offset(x: offset.width \* 5, y: 0)

.opacity(2 - Double(abs(offset.width / 50)))

.gesture(

DragGesture()

.onChanged {gesture **in**

offset = gesture.translation

}

.onEnded { \_ **in**

**if** abs(offset.width) > 100 {

// Remove card

removal?()

} **else** {

offset = .zero

}

}

)

}

}

In the ConventView.swift we will put some images to clarify which side is positive and which one is negative:

First, add the following property:

@Environment(\.accessibilityDifferentiateWithoutColor) **var** differentiateWithoutColor

And below the VStack, add the following code:

**if** differentiateWithoutColor {

VStack {

Spacer()

HStack {

Image(systemName: "xmark.circle")

.padding()

.background(.black.opacity(0.7))

.clipShape(Circle())

Spacer()

Image(systemName: "checkmark.circle")

.padding()

.background(.black.opacity(0.7))

.clipShape(Circle())

}

.foregroundColor(.white)

.font(.largeTitle)

.padding()

}

}

## Counting down with a Timer

To add a timer we will start by adding these two properties to the ContentView:

@State **private** **var** timeRemaining = 100

**let** timer = Timer.publish(every: 1, on: .main, in: .common).autoconnect()

That gives the user 100 seconds to start with, then creates and starts a timer that fires once a second on the main thread.

Then, add this modifier to the outermost Zstack:

.onReceive(timer) { time **in**

**if** timeRemaining > 0 {

timeRemaining -= 1

}

}

To display the timer, add the following code inside the VStack and before the ZStack that shows the cards:

Text("Time: \(timeRemaining)")

.font(.headline)

.foregroundColor(.white)

.padding(.horizontal, 20)

.padding(.vertical, 5)

.background(.black.opacity(0.75))

.clipShape(Capsule())

There is something else we need to add, because with this code, when the app goes to background, the timer runs for a few seconds, then pauses until the app comes back. So, add these two properties to ContentView:

@Environment(\.scenePhase) **var** scenePhase

@State **private** **var** isActive = **true**

The environment value tells us whether the app is active or inactive in terms of its visibility, but we’ll also consider the app inactive is the player has gone through their deck of flashcards – it will be active from a scene phase point of view, but we don’t keep the timer ticking.

Now add this **onChange()** modifier below the existing **onReceive()** modifier:

.onChange(of: scenePhase) { newPhase **in**

**if** newPhase == .active {

isActive = **true**

} **else** {

isActive = **false**

}

}

And finally, modify the onReceive(timer) function so it exits immediately if isActive is false:

.onReceive(timer) { time **in**

**guard** isActive **else** { **return** }

**if** timeRemaining > 0 {

timeRemaining -= 1

}

}

## Ending the app with allowsHitTesting()

SwiftUI lets us disable interactivity for a view by setting **allowsHitTesting()** to false, so in our project we can use it to disable swiping on any card when the time runs out by checking the value of **timeRemaining**.

ZStack {

ForEach(0..<cards.count, id: \.**self**) { index **in**

CardView(card: cards[index]){

withAnimation(){

removeCard(at: index)

}

}

.stacked(at: index, in: cards.count)

}

}

// Enable hit testing when there is still time

.allowsHitTesting(timeRemaining > 0)

// Add a button to trigger the reset cards

**if** cards.isEmpty {

Button("Start Again", action: resetCards)

.padding()

.background(.white)

.foregroundColor(.black)

.clipShape(Capsule())

}

In the innermost ZStack of ContentView.swift, we will add the allowHitTesting modifier setting the condition that there should be still time.

After that we validate if there are still cards, if there are no more cards, we show a button to restart the cards again calling the resetCards method.

**func** removeCard(at index: Int){

cards.remove(at: index)

**if** cards.isEmpty {

isActive = **false**

}

}

// Reset the cards including the timer

**func** resetCards(){

cards = [Card](repeating: Card.example, count: 10)

timeRemaining = 100

isActive = **true**

}

For the removeCard method, we add the code to validate if there are more cards, otherwise we set the isActive property to false. But we also need to make sure isActive stays false when returning from the background, so we update our scene phase code so it explicitly checks for cards:

.onChange(of: scenePhase) { newPhase **in**

**if** newPhase == .active {

**if** cards.isEmpty == **false** {

isActive = **true**

}

} **else** {

isActive = **false**

}

}

## Making iPhones vibrate with UINotificationFeedbackGenerator

iOS offers several ways to generate haptic feedback, one of them is creating an instance of one of the subclasses of UIFeedbackGenerator then triggering it when you’re ready, but for more precise control over feedback you should first call its **prepare()** method to give the Taptic Engine chance to warm up.,which reduces latency and has a battery impact.

UINotificationFeedbackGenerator is a subclass that provides success and failure haptics. We can add once centrl instance of if to every ContentView but this casues that ContentView gets notified whenever a card has been removed, but *isn’t* notified when a drag is in progress, which means we don’t have the opportunity to warm up the Taptic Engine.

So, we will give each CardView its own instance so they can prepare and play them as needed.

Add this new property to **CardView**:

@State private var feedback = UINotificationFeedbackGenerator()

It is OK to call prepare() then never triggering the effect – the system will keep the Taptic Engine ready for a few seconds then just power it down again. Also, it’s perfectly allowable to call **prepare()** many times before triggering it once – **prepare()** doesn’t pause your app while the Taptic Engine warms up, and also doesn’t have any real performance cost when the system is already prepared.

After that, change the onChanged gesture code for this:

DragGesture()

.onChanged {gesture **in**

offset = gesture.translation

feedback.prepare()

}

## Fixing the Bugs

To avoid that users can drag cards around when they are not at the top, add the following line just below the stacked modifier in ContentView:

.stacked(at: index, in: cards.count)

.allowsHitTesting(index == cards.count - 1)

When using VoiceOver and tap on the background image, it can be read as “white background, image”. To fix this, we should make it decorative:

Image(decorative: "white-background")

To avoid cards from below to be accessible, add the following line just below the .allowsHitTesting modifier:

.accessibilityHidden(index < cards.count - 1)

In the CardView.swift, we will add the following line to the ZStack so the system will read “Who played the 13th Doctor in Doctor Who? Button” – an important hint to users that the card can be tapped.

.accessibilityAddTraits(.isButton)

SwiftUI provides a specific environment property that tells us when VoiceOver is running, called **accessibilityVoiceOverEnabled**. So, add this new property to **CardView**:

@Environment(\.accessibilityVoiceOverEnabled) **var** voiceOverEnabled

Then, show the prompt and answer in the same text view if the voiceOver is enabled:

VStack{

// Show the prompt and answer in a single text view if voice over is enabled

**if** voiceOverEnabled {

Text(isShowingAnswer ? card.answer : card.prompt)

.font(.largeTitle)

.foregroundColor(.black)

} **else** {

Text(card.prompt)

.font(.largeTitle)

.foregroundColor(.black)

**if** isShowingAnswer {

Text(card.answer)

.font(.title)

.foregroundColor(.gray)

}

}

}

We will also make it easier for users to mark cards as correct or wrong. The SF Symbols of the images are read out as “checkmark, circle, image” rather than anything useful.

So, replace the images with buttons that actually remove the cards. Replace the current HStack in the ContentView with this:

HStack {

Button{

withAnimation {

removeCard(at: cards.count - 1)

}

} label:{

Image(systemName: "xmark.circle")

.padding()

.background(.black.opacity(0.7))

.clipShape(Circle())

}

.accessibilityLabel("Wrong")

.accessibilityHint("Mark your answer as being incorrect.")

Spacer()

Button {

withAnimation {

removeCard(at: cards.count - 1)

}

} label: {

Image(systemName: "checkmark.circle")

.padding()

.background(.black.opacity(0.7))

.clipShape(Circle())

}

.accessibilityLabel("Correct")

.accessibilityHint("Mark your answer as being correct.")

}

To avoid the buttons remain onscreen even when the last card has been removed, add the following guard check to the removeCard method to make sure we don’t remove a card that doesn’t exist:

**func** removeCard(at index: Int){

**guard** index >= 0 **else** { **return** }

## Adding and deleting cards

In the ContentView add a new property:

@State **private** **var** showingEditScreen = **false**

Add a button to flip that Boolean when tappe. Before the **if** differentiateWithoutColor || voiceOverEnabled { add this code:

VStack {

HStack {

Spacer()

Button {

showingEditScreen = **true**

} label: {

Image(systemName: "plus.circle")

.padding()

.background(.black.opacity(0.7))

.clipShape(Circle())

}

Spacer()

}

}

.foregroundColor(.white)

.font(.largeTitle)

.padding()

Make the Card struct to conform to Codable:

**struct** Card: Codable {