Getting Started with WidgetKit

Create Widgets for iOS and iPadOS

Sagun Raj Lage
Prakshapan Shrestha

Apress®

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To all my teachers, seniors, mentors, friends, and juniors. You are my gems. I feel blessed to have you in life. Thank you for everything!

—Sagun Raj Lage

To my dear mother.

—Prakshapan Shrestha

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Before You Begin…

Before you start exploring the beauty and power of WidgetKit through this book, you will need to make sure you have the following prerequisites set up:

- **A Mac running macOS Catalina (version 10.15.4) or later**: However, we recommend a Mac running macOS Big Sur (version 11) or later as the code was tested on that version.
- **Xcode 12 or later**: Xcode is the primary tool used to develop apps for the Apple ecosystem. You can download the latest version of Xcode from Apple's developer site.[1] We recommend using Xcode 12.4 or later as the code was tested on that version.
- **Swift 5 or later**: Since the new versions of Xcode ship with the updated versions of Swift, you need not worry about this.
- **Simulators and devices with iOS 14 or later installed** since the WidgetKit framework, the framework you will use to develop widgets, is only supported from iOS 14.

[1] https://developer.apple.com/xcode/

- **A Twitter Developer Account**: In the last chapter of this book, you will develop a widget that will use Twitter's API. And you will get access to Twitter's API only after you own a Twitter Developer Account. You can apply for a developer account from Twitter's developer account page.[2]

  Generally, it takes a day or two, or sometimes even more, for Twitter to review your application and approve or reject it. Therefore, it is a nice idea to apply for that account before beginning this book so that when you reach the last chapter, your Twitter Developer Account will be ready to use.

[2] https://developer.twitter.com/en/apply-for-access

CHAPTER 1

Getting Familiar with WidgetKit in a Flash

This chapter will quickly introduce you to WidgetKit, Apple's framework to develop beautiful and handy widgets for iOS homescreen and macOS Notification Center.

Background

WWDC20 brought forward a number of exciting changes and features in the Apple ecosystem. It caught the attention of not only the developers but also of the end users, since it introduced some changes that carry the potential to shape the future of the overall Apple ecosystem experience.

People were anticipating the release of the latest version of iOS in the 20th edition of WWDC, and they got exactly what they were waiting for – iOS 14, a package of awesome features and enhancements! Among those features and enhancements, widgets created a lot of buzz in the market.

Before iOS 14, widgets had very limited features, and they could be seen in a vertical list of full-width boxes on the Today screen (the screen to the left of the first page of the homescreen). That was quite an injustice for

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widgets! But iOS 14 has changed the way iOS treated widgets. Now widgets can contain more information and can show up in various sizes. And the best part is that they are no more confined to be on the Today screen. They can be dragged off the Today screen and placed on the homescreen, together with app icons. And trust us, they look beautiful together.

Now you must be thinking, "Okay, enough of the talks! How can I start?" The next section tells you everything about it.

Hello, WidgetKit!

Apple introduced the WidgetKit framework to enable developers to develop widgets of their apps. The beauty of widgets is that users can get the latest information at a glance, without having to launch the app. And in case users need more details, they can tap on the widget to navigate to the appropriate location in the app.

WidgetKit allows you to create widgets of three different sizes – small, medium, and large. These widgets can be used to display different amount of information. For example, if you have a weather app, you can use the small-sized widget to display only the current temperature in degree Fahrenheit or degree Celsius. The medium-sized widget can display the current location and the temperature. And since the large-sized widget has a greater space, you can use it to display the current location, the temperature, and a brief weather report of the day. And if the users want a detailed report, they can launch the app by tapping the widget. So, for companies, businesses, and developers, widgets are a nice way to keep their users attracted and engaged to their app.

Note Before developing widgets, you must keep in mind that the WidgetKit framework is available only in iOS 14 and above. So, consider your target users before development. Also, you will require basic SwiftUI knowledge and Xcode 12 or above to be able to develop widgets.

Summary

Now you have gained some familiarity with WidgetKit, Apple's framework to develop widgets of various sizes. Also, you now have an idea about how widgets can help users to get up-to-date information at a glance and how developers can develop beautiful and handy widgets to keep their users attracted and engaged to their app. Plus, you have learned that iOS 14 is the minimum iOS version that supports widgets, and Xcode 12 is the minimum version of Xcode that can be used to develop widgets.

Since SwiftUI is used to develop widgets, in the upcoming chapter, we will give you an overview of SwiftUI and its views that you will use to create widgets. You will learn more about the various sizes of widgets you can create, and you will get an overview of Apple's Human Interface Guidelines (HIG) for widgets.

EXERCISES

1. Go through the overview section of the official documentation of WidgetKit from `https://developer.apple.com/documentation/widgetkit/`. It can help you get a different perspective to understand things. You can explore other sections too, if you are interested.

2. Try completing at least the first chapter, SwiftUI Essentials, from `https://developer.apple.com/tutorials/swiftui/`, if you haven't given SwiftUI a try. This tutorial will help you understand the basics and make you ready for the next chapter of our book.

CHAPTER 2

SwiftUI, Human Interface Guidelines, and Widget Family

Now that you have a general idea about WidgetKit, you can move forward to learn about some basic building blocks of a widget. In this chapter, you will learn about some views of SwiftUI that will act as the building blocks of your widget. Then, you will get an overview of Apple's Human Interface Guidelines for creating intuitive, easy-to-learn, and consistent user interface for widgets. In addition to these, you will learn more about `WidgetFamily` that enables you to create widgets of various sizes.

SwiftUI

In WWDC 2019, Apple introduced SwiftUI – a framework that brought a major change in the way iOS apps are developed. Before the introduction of SwiftUI, there existed debates between developers about whether they should use Storyboards or develop the app UI programmatically. SwiftUI flushed out the debate and brought a new and easier way to create

S. R. Lage and P. Shrestha, *Getting Started with WidgetKit*,
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beautiful and interactive user interfaces with eye-pleasing animations and transitions. Note the phrase “new and easier way.” There are three major reasons why developing apps using SwiftUI is easier:

1. **SwiftUI uses a declarative approach of programming**: A declarative approach allows you to describe how your app’s user interface looks like and what you want your app to do when a state changes, without getting into much details. This decreases the amount of code and makes it easier to read, understand, and modify. Before SwiftUI, we used an imperative approach of programming, meaning that we had to write detailed step-by-step instructions to lay out the user interface and control the states. This generally led to a large volume of code. With SwiftUI, things have become simpler.

2. **Bid farewell to Storyboard and Auto Layout**: Before SwiftUI, developers who didn’t prefer developing a user interface programmatically used Storyboard. Using Storyboard was a nice way, but there was a hassle of using Auto Layout to make the app’s interface look consistent on all screen sizes. But now, SwiftUI has introduced a number of views (like stacks and spacer) and their properties (like padding) to make user interface appear consistent with lesser effort.

3. **Learn once, apply anywhere**: SwiftUI is a unified user interface framework to build a user interface for all types and sizes of Apple devices. It means that you can easily port the UI code you wrote for

iOS to macOS or watchOS without modifications or with minimum modifications. Before the launch of SwiftUI, we had to use different frameworks to develop apps for different platforms – UIKit for iOS, AppKit for macOS, WatchKit for watchOS, and TVUIKit for tvOS.

Due to these reasons, we think that SwiftUI deserves the honor of being called a lifesaver.

In SwiftUI, views act as the visual building blocks of the user interface of your app. They are used to display texts, images, shapes, and drawings in your app. Some views like `TextField`, `Button`, `Slider`, and `Picker` even allow users to interact with them to manipulate data and the user interface. What's more interesting is that you can combine two or more views to give birth to complex views too.

Widgets are also developed using SwiftUI. So, you will use SwiftUI's views to bring your widget to life. There is a wide variety of views that you can use to develop widgets. However, an overview of some basic views that are used more often will suffice.

Basic SwiftUI Views for Widgets

Let's go through some basic SwiftUI views that are often used to create widgets.

Text

You can use `Text` to display one or more lines of read-only text in your app or widget. For example, if you want your app or widget to display the text "SwiftUI is fun!", you can write `Text("SwiftUI is fun!")`. You can also modify the appearance and size of the text and view by playing with its methods like `font()`, `italic()`, `bold()`, `lineLimit()`, and so on.

Button

Button is one of the most commonly used items in user interfaces. It is able to perform an action when it is triggered through events. Its initializer takes two arguments – an action and a label. Let's write some code to create a button that prints "Buttons are good!".

In Listing 2-1, the button contains an action that prints "Buttons are good!" when it is triggered.

Listing 2-1. A button in SwiftUI

```
Button(action: {
      print("Buttons are good!")
}) {
      Text("Tap me")
}
```

The second argument is a `Text` view that gives the button its title. However, you can use other views here to change the composition of the button and leverage various methods that a button provides to change its appearance and size.

Are you thinking where you can use buttons in your widgets? Assume that you have a to-do list app and your widget needs to display the items that haven't been completed yet. You have planned to represent each item by an empty checkbox, followed by text. So, in this case, you can use a button to create the checkbox, which when tapped removes the item from the to-do list. Simple, right?

Image

The name itself makes it clear that you can use an `Image` view to display images in your app or widget. In the upcoming lesson, you will create widgets that will display logos of football clubs. And you will use `Image` views there.

The `Image` view provides various methods to style the image it holds.

You can load an image stored in your Assets.xcassets folder by using the `Image(uiImage: UIImage)` initializer. For example, if the name of the image is "background," you can load it in the `Image` view by writing `Image(uiImage: #imageLiteral(resourceName: "background"))`.

There exists another variety of the `Image` view initializer. It allows you to load system symbol images provided by Apple. The initializer takes a `String` argument, and it is the name of the system symbol image that you want to use.

For example, if you want to load the trash icon, you can use its system symbol name, `"trash"`, and pass it in the initializer by writing `Image(systemName: "trash")`.

Tip You can use the SF Symbols[1] app to look up the names of system symbol images.

HStack

`HStack` is a view that arranges its child views horizontally. It allows you to create a horizontal stack that arranges the views side by side. In the upcoming chapter, you will use `HStack` to create views that will display the name and the logo of a football club side by side horizontally. In Listing 2-2, you will create an `HStack` that holds a `Text` and a `Button`.

[1] https://developer.apple.com/sf-symbols/

Listing 2-2. HStack in action

```
HStack {
      Text("New user?")
      Button(action: {
          print("Register button is tapped.")
      }) {
          Text("Register")
      }
}
```

Listing 2-2 shows an `HStack` in action. The `HStack` holds a `Text` view that displays "New user?", followed by a button displaying "Register." Figure 2-1 shows the screenshot of the result of Listing 2-2.

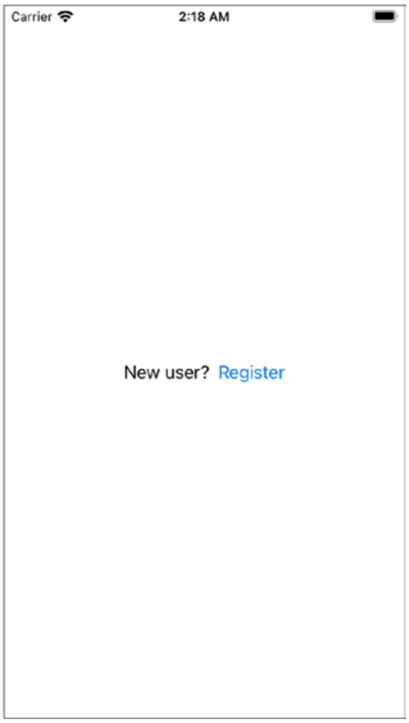


Figure 2-1. *An `HStack` displaying a `Text` and a `Button`*

In addition, `HStack` allows you to change the spacing between the items and the alignment of the items.

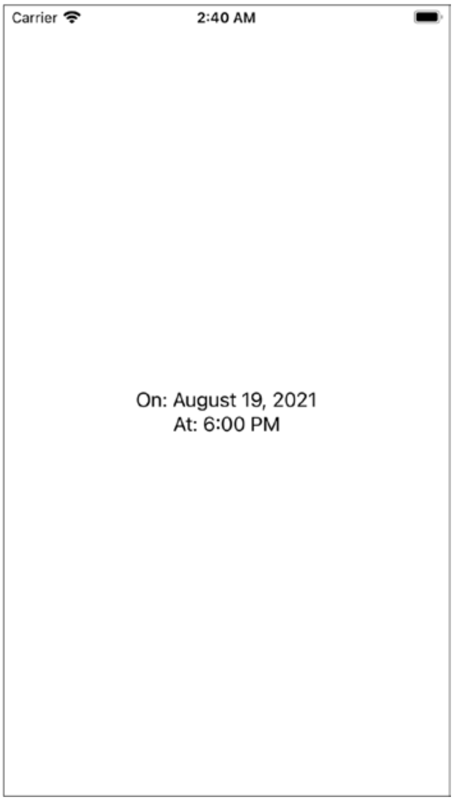
VStack

`VStack` enables you to create a vertical stack of views. In the upcoming chapter, you will use `VStack` to create views that will display the date and time of the upcoming football match in a vertical fashion. The code you will write will be similar to the code given in Listing 2-3.

Listing 2-3. VStack in action

```
VStack {
      Text("On: August 19, 2021")
      Text("At: 6:00 PM")
}
```

Listing 2-3 is the code to create a vertical stack that displays the date and time of the upcoming match. Figure 2-2 shows the screenshot of the result of Listing 2-3.



On: August 19, 2021
At: 6:00 PM

Figure 2-2. *A `VStack` displaying two `Text` views*

Like `HStack`, `VStack` also allows you to change the spacing between the items and the alignment of the items.

ZStack

Assume that you want to place some text over a picture. That is where `ZStack` comes into action! `ZStack` is SwiftUI's special type of stack that overlaps views. Listing 2-4 shows the code to create a `ZStack` that places the text "Welcome" over a picture.

Listing 2-4. ZStack in action

```
ZStack {
      Image(uiImage: #imageLiteral(resourceName: "welcome-bg"))
      Text("Welcome")
}
```

In Listing 2-4, we have written the `Image` view before the `Text` view because we want the `Text` view to appear over the `Image` view. Figure 2-3 shows the screenshot of the result of Listing 2-4.

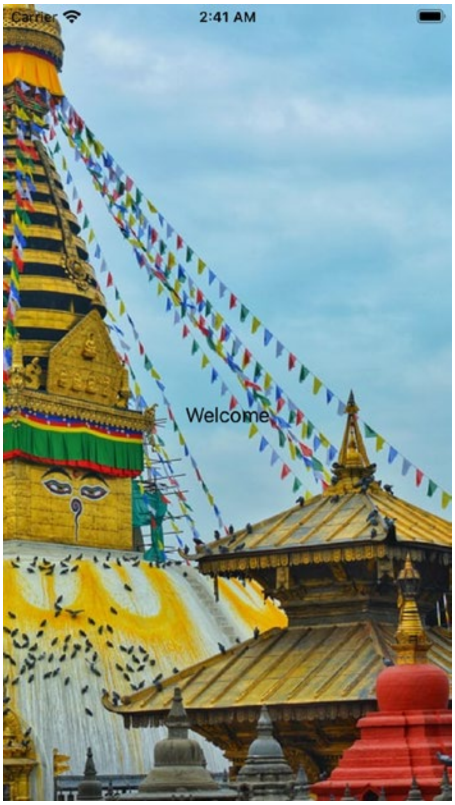


Figure 2-3. *A `ZStack` displaying a `Text` view over an `Image` view*

Note The view that you want to display on the foreground should be written in the last line of the `ZStack` block.

`ZStack` allows you to change the alignment of the child views that you include in it. However, you cannot change the spacing between the items since it doesn't make sense.

Human Interface Guidelines

Human Interface Guidelines (HIG)[2] are the recommendations Apple gives to the developers for developing apps with intuitive, easy-to-learn, and consistent user interface. You can consider HIG as an instruction manual containing the *dos and don'ts* of user interface development for Apple platforms.

Apple has prepared Human Interface Guidelines for developing widgets too, and they help you understand what the qualities of a good widget are and how you can develop such widgets. In short, the Human Interface Guidelines suggest the following:

- Keep your widget focused upon a specific idea or purpose and use it to display relevant content so that users can get useful information at a glance, without launching the app. Also, avoid creating a widget that simply launches the app, as the app icon already does it. In addition to this, just because WidgetKit allows you to develop various sizes of widgets does not mean that you should always develop widgets of all sizes. Do it only when it adds value to your app.

[2] https://developer.apple.com/design/human-interface-guidelines/ios/system-capabilities/widgets/

- You can allow widgets to be user configurable. But make your widgets configurable only if your widgets require users to configure them so that the widgets can deliver the best output. Another interesting thing about widgets is that you can add tap targets in them to make navigation to relevant screens possible from the widget. However, avoid adding too many tap targets as it may give a bad user experience.
- A widget's main function is to display fresh content. So, make sure to figure out a proper update frequency by analyzing how often changes are seen in the data and by estimating how often people need to see updated data in your widget.
- You can make your widget stand out from the crowd of app icons and widgets by using your brand colors, typefaces, and icons. However, displaying your logo, wordmark, or app icon in the widget does not make sense in most of the cases. Likewise, make sure that the content density does not look crowded and your design elements and colors do not make it difficult for users to see the information your widget is trying to deliver. In addition, adding support for dark mode, giving a realistic preview of the widget along with a proper description, and making use of placeholder content for better user experience create a good impression in front of users.
- Since users using variable-sized devices will install your app and widgets, it is necessary for you to ensure that they adapt well to those screen sizes. For that, size the images you use in your widgets according to the

size table given under the **Size images to look great on large devices and at high scale factors** heading in the Human Interface Guidelines for widgets.[3] Also, ensure that your texts and glyphs adapt well under the various screen sizes. And use ContainerRelativeShape to ensure that the content of your widget looks good within the rounded corners of the widget.

Widget Family

By now, you must have known that the WidgetKit framework allows you to create widgets of various sizes – small, medium, and large. For this purpose, you can use a special enum, `WidgetFamily`. It consists of three cases – `systemSmall`, `systemMedium`, and `systemLarge`. And by looking at the names of the cases, you can easily guess which case is responsible for which size.

This variety in widget sizes gives users the freedom to place and configure their widgets the way they prefer. Since each widget size can accommodate different amounts of content and information within it, it is up to the developers like you to choose what volume of content and information you would like to display.

Just to give you a bird's eye view at how you can use the three cases of `WidgetFamily` to support various widget sizes, we have borrowed some code from the official documentation[4] and pasted it in Listing 2-5.

[3] https://developer.apple.com/design/human-interface-guidelines/ios/system-capabilities/widgets/

[4] https://developer.apple.com/documentation/widgetkit/staticconfiguration

Listing 2-5. A widget that supports all three widget families

```
struct GameStatusWidget: Widget {
    var body: some WidgetConfiguration {
        StaticConfiguration(
            kind: "com.mygame.game-status",
            provider: GameStatusProvider(),
            placeholder: GameStatusPlaceholderView()
        ) { entry in
            GameStatusView(entry.gameStatus)
        }
        .configurationDisplayName("Game Status")
        .description("Shows an overview of your game status")
        .supportedFamilies([.systemSmall, .systemMedium,
        .systemLarge])
    }
}
```

You can see in Listing 2-5 that a widget named `GameStatusWidget` has been created. You can ignore other lines and just pay attention to the line that says `.supportedFamilies([.systemSmall, .systemMedium, .systemLarge])`. This is the line that defines which sizes of widgets your app should support.

`supportedFamilies(_:)` is an instance method of the `WidgetConfiguration` protocol. It takes an array of `WidgetFamily` cases as an argument and is used to set the sizes that a widget supports. Since the `StaticConfiguration` struct, used in Listing 2-5, conforms to the `WidgetConfiguration` protocol, it can access `supportedFamilies(_:)` to set the widget size.

Therefore, in Listing 2-5, the array `[.systemSmall, .systemMedium, .systemLarge]` has been passed as an argument to `supportedFamilies(_:)` to set the supported sizes to small, medium, and large.

Tip We know, you may face difficulties while trying to understand the things we described earlier. But do not worry since we will use them in the exercises of our upcoming chapters. For now, you're doing great!

In case you want your app to support only a single size of widget, that's possible too. Assume that you want your app to support only a medium-sized widget. For that, you can create an array containing a `.systemMedium` case and pass it to `supportedFamilies(_:)` by writing `.supportedFamilies([.systemMedium])`. As simple as that!

Summary

By completing this chapter, you have learned about the SwiftUI views that can be used as building blocks to create widgets of your app. Likewise, you got an overview of Apple's Human Interface Guidelines for widgets that familiarized you with the purpose of widgets and gave you tips to develop intuitive, easy-to-learn, and consistent user interface for widgets. In addition to these, you learned more about `WidgetFamily` that enables you to create widgets of various sizes.

The next chapter will teach you some important concepts of widgets – timelines and links. But fear not – we are here to guide you!

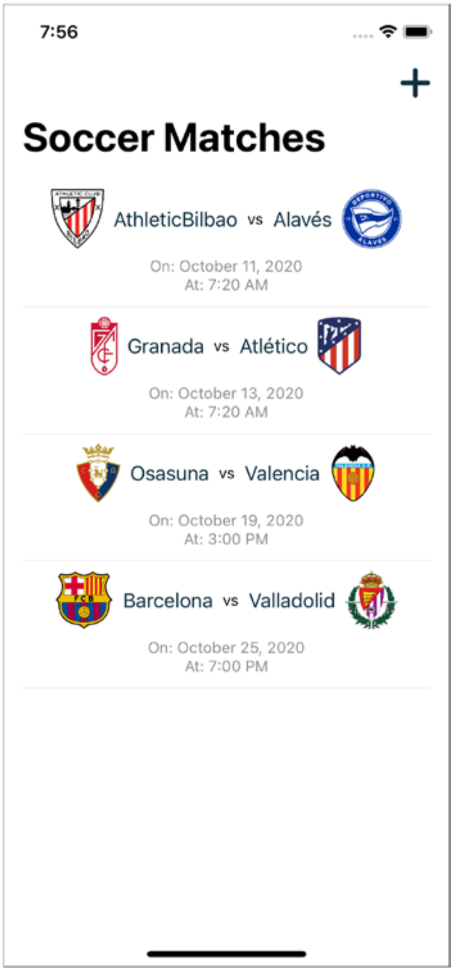
CHAPTER 3

Writing Your First Widget

Now comes the chapter in which you will finally get to make your hands dirty by working on a project. In this chapter, you will create a widget extension of an existing project and break that widget extension down to see what it is made up of – timeline, timeline provider, widget view, placeholder, snapshot, and widget configuration.

We have prepared a starter project so that you can get straight into creating its widget. Find the zip file named **SoccerTime.zip** and unzip it to get started with the project.

If you've successfully unzipped **SoccerTime.zip** and opened the **SoccerTime.xcodeproj** file of the **SoccerTimeStarter** folder, you will know that **SoccerTime** is the project we will be working on. **SoccerTime** is an app that displays the details of the upcoming soccer matches of your favorite teams. It consists of two screens – one for adding upcoming matches (Figure 3-1) and the other for displaying a list of the matches you add (Figure 3-2). Launch the app and add some matches with future date to understand the features more clearly.


7:56

Soccer Matches

AthleticBilbao vs Alavés
On: October 11, 2020
At: 7:20 AM

Granada vs Atlético
On: October 13, 2020
At: 7:20 AM

Osasuna vs Valencia
On: October 19, 2020
At: 3:00 PM

Barcelona vs Valladolid
On: October 25, 2020
At: 7:00 PM

Figure 3-1. *The screen that displays the list of upcoming matches in SoccerTime*

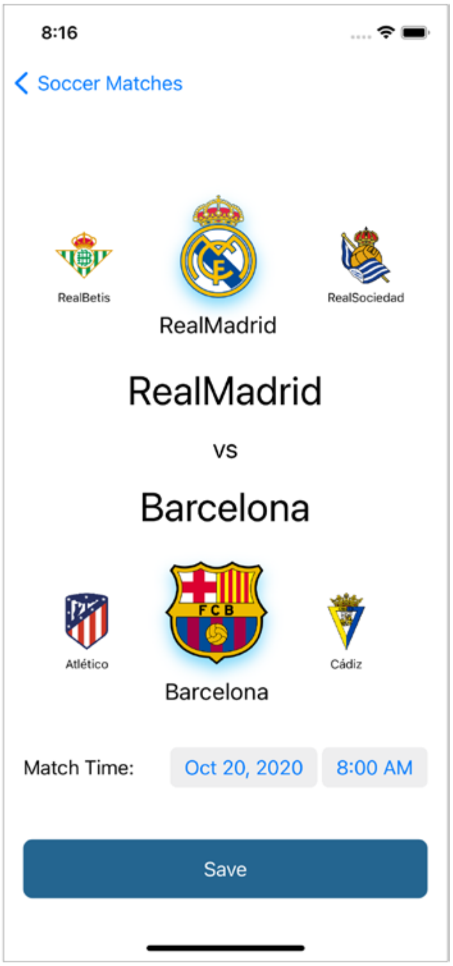


Figure 3-2. *The screen from where users add their favorite upcoming matches*

Now here comes the interesting part – you will create **SoccerTime**'s widget that will display information about the forthcoming matches you add in the app. You will create a small-sized widget that will display the logos of the two teams competing in the nearest upcoming match and a countdown before the match begins. The widget will look like Figure 3-3.

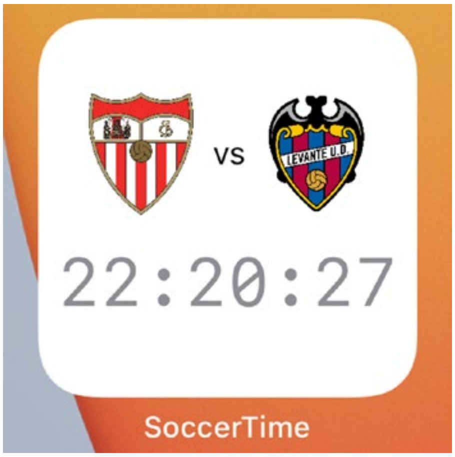


Figure 3-3. *The small-sized widget of SoccerTime*

So, the first step is to add a widget extension to the project, and the upcoming section describes everything about it.

Widget Extension

The widget extension is a template that provides a basic structure and boilerplate code to help you get started with creating your app's widget. It holds the widgets that you create. Apple recommends developers to include all the widgets of an app in a single widget extension. However, it's also possible to create multiple widget extensions, if necessary.

To create a widget extension of SoccerTime, follow the steps given as follows:

1. Open **SoccerTime.xcodeproj**.
2. Go to **File ➤ New ➤ Target ➤ iOS**.
3. You can either scroll down or use filter to find **Widget Extension**. Then double-click it.

4. Now a dialog box will appear where you will do the following:

   a. Set **Product Name** to **SoccerTimeWidget**.

   b. Set **Team** to either **None** or choose your team.

   c. Uncheck **Include Configuration Intent**.

   d. Make sure that **SoccerTime** is the selected **Project**.

   e. Verify that **SoccerTime** is the selected application in the **Embed in Application** field.

   f. Click **Finish**.

5. Once you click finish, the widget extension gets generated, and Xcode will ask one final question, "Activate 'SoccerTimeWidgetExtension' scheme?". Click **Agree** so that that scheme is activated. The change you will see in your Xcode screen after that is shown in Figure 3-4.

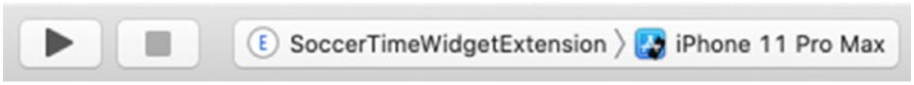


Figure 3-4. *A screenshot displaying SoccerTimeWidgetExtension as the selected scheme*

After you've followed the steps mentioned earlier, the first thing you will notice is the addition of the **SoccerTimeWidget** folder in the project. This is where everything related to your widgets is kept.

From the **SoccerTimeWidget** folder, open **SoccerTimeWidget.swift** to see the boilerplate code of the building blocks of your widget. You will be making changes in this file to customize your widget. Now, we will give you an overview of all the blocks in **SoccerTimeWidget.swift**. Also, we will guide you to make changes in that file so that you can create widgets that will allow users to see the details of the upcoming matches in their homescreen.

Note Notice in the Target Membership section of File Inspector that **SoccerTimeWidget.swift** has its target set to **SoccerTimeWidgetExtension** instead of the **SoccerTime**.

TimelineEntry

`TimelineEntry` is a protocol that specifies when a widget should be displayed. It consists of a `date` property for indicating that. Also, it can help the system determine the relevance of the widget's content. These capabilities of `TimelineEntry` are capitalized by `TimelineProvider` by managing one or more timeline entries to tell WidgetKit when to display a widget. Then, WidgetKit renders the widget by executing the `content` block of the widget configuration, passing the corresponding timeline entry.

Note We know that you aren't familiar with `TimelineProvider` and `WidgetConfiguration` yet, but you will get to know them in the upcoming sections. For now, you can just keep in mind that `TimelineProvider` manages timeline entries and `WidgetConfiguration` is the place from where you configure the widget.

To use the features of `TimelineEntry`, you create a struct that conforms to it. Since it is a type of model that `WidgetConfiguration` will require to render the widget, you have to make sure you add all the properties that `WidgetConfiguration` will need.

In the current project, if you go to **SoccerTime ➤ Model ➤ Match.swift**, you will see a model that the app is using to store details about a match. Since your widget will display the same details that `Match` helps to store, you can use this model.

If you look at the structure of `Match`, you will notice that it conforms to `Codable` and `Identifiable` protocols. Now, to make it usable even as a timeline entry, make it conform to the `TimelineEntry` protocol. For that, WidgetKit needs to be imported first. So, in **Match.swift**, add the line `import WidgetKit` at the first line.

Then, make `Match` conform to `TimelineEntry` by modifying it and making it look like Listing 3-1.

Listing 3-1. Making a model conform to TimelineEntry

```
struct Match: Codable, Identifiable, TimelineEntry {
      var id = UUID()
      var primaryClub: String
      var secondaryClub: String
      var date: Date
}
```

If you build the project right now, you will encounter an error saying, "Match does not conform to protocol 'TimelineEntry'." It is because a struct conforming to `TimelineEntry` compulsorily needs to have a `date` property of `Date` type. If you look thoroughly at `Match`, you will see that there already is a property of `Date` type, that is, `time`. So, you can rename it to `date` since the `time` property was there for the same purpose – to store date.

Now build the project and you will see that the renaming affected the whole project. You will see errors in `ListMatchView`, `MatchCell`, and `AddMatchView`. Rename `time` to `date` in all those places and build the project to find all errors gone.

TimelineProvider

`TimelineProvider` can be considered as the driving force of the widget. It is a protocol that lets WidgetKit know when it should update a widget's display. It fetches entries of type `TimelineEntry` and displays each entry at the time stored in the entry's `date` property.

Now, you will create a struct that conforms to `TimelineProvider`. But before that, create a folder named **SmallWidget** in the **SoccerTimeWidget** folder to store all the files related to the small variant of your widget.

Then, in the **SmallWidget** folder, create a Swift file and name it **SmallWidgetDataProvider**. Before clicking Create, make sure to check **SoccerTimeWidgetExtension** in the Targets section so that **SmallWidgetDataProvider** becomes available in your widget extension too.

Now, open **SmallWidgetDataProvider.swift** and replace the existing code from that file with the code in Listing 3-2.

Listing 3-2. Creating SmallWidgetDataProvider

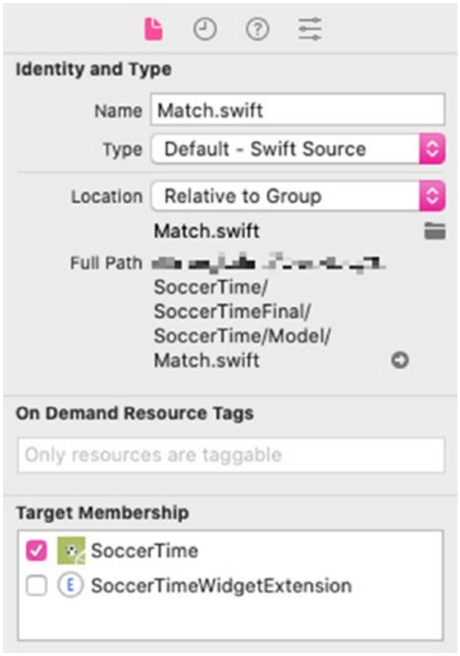
```
import SwiftUI
import WidgetKit

struct SmallWidgetDataProvider: TimelineProvider {


}
```

Listing 3-2 imports SwiftUI and WidgetKit and creates a struct named `SmallWidgetDataProvider` that conforms to `TimelineProvider`.

Now, you'll see an error saying "Type 'SmallWidgetDataProvider' does not conform to protocol 'TimelineProvider'." It is because you still haven't implemented the methods of that protocol. For now, you can ignore that error.

Now add the line `typealias Entry = Match` to **SmallWidgetDataProvider**. That line implements the `Entry typealias` property of the `TimelineProvider` protocol in `SmallWidgetDataProvider`. As stated earlier, this is how you are feeding `SmallWidgetDataProvider` (a timeline provider) a timeline entry (`Match`). Build the project.

Now you must be seeing a new error that says, “Cannot find type ‘Match’ in scope.” The reason behind this error is that **Match.swift** is not a member of the **SoccerTimeWidgetExtension** target, hence not being available in your widget extension. If you open **Match.swift**, you will see in the Target Membership section of File Inspector that only **SoccerTime** has been checked, and not **SoccerTimeWidgetExtension**. Right now, the Target Membership section looks like Figure 3-5.



Identity and Type

Name: Match.swift
Type: Default - Swift Source
Location: Relative to Group
Match.swift
Full Path: [redacted] SoccerTime/SoccerTimeFinal/SoccerTime/Model/Match.swift

On Demand Resource Tags

Only resources are taggable

Target Membership

[✓] SoccerTime
[ ] SoccerTimeWidgetExtension

Figure 3-5. *A screenshot displaying Match.swift’s target membership*

Since you need to use `Match` in **SoccerTimeWidgetExtension** too, add a checkmark on it.

It's time to get rid of the only remaining error saying, "Type 'SmallWidgetDataProvider' does not conform to protocol 'TimelineProvider'." Open the error and click **Fix**. Then it will generate the boilerplate code of `TimelineProvider`'s methods, and the code will look similar to Listing 3-3.

Listing 3-3. Boilerplate code of SmallWidgetDataProvider

```
import WidgetKit
import SwiftUI

struct SmallWidgetDataProvider: TimelineProvider {

    typealias Entry = Match

    func placeholder(in context: Context) -> Match {
        <#code#>
    }

    func getSnapshot(in context: Context, completion: @escaping
    (Match) -> Void) {
        <#code#>
    }

    func getTimeline(in context: Context, completion: @escaping
    (Timeline<Match>) -> Void) {
        <#code#>
    }

}
```

Listing 3-3 shows the code of `SmallWidgetDataProvider`. There is boilerplate code of the three methods of `TimelineProvider` (that `SmallWidgetDataProvider` conforms to), and it's the developer's job to write their implementations. The basic overview of those methods is given as follows, along with some hands-on work for you.

placeholder(in:)

A placeholder displays a generic representation of your widget view during its first load after being added to the homescreen. It can also be displayed while your widget is in the process of retrieving new data.

In WidgetKit, the `placeholder(in:)` method of `TimelineProvider` is responsible to return a placeholder timeline entry.

Let's give it a try. After the line that says `typealias Entry = Match` in `SmallWidgetDataProvider`, create a variable `placeholderEntry` of `Match` type that returns a placeholder timeline entry. It is shown in Listing 3-4.

Listing 3-4. Declaration of a placeholderEntry variable

```
var placeholderEntry: Match {
      return Match(primaryClub: "none",
                   secondaryClub: "none",
                   date: Date())
}
```

As stated earlier, Listing 3-4 declares a variable `placeholderEntry` of `Match` type and returns a `Match` object (that conforms to `TimelineEntry`) with `primaryClub` and `secondaryClub` values set to `"none"` and the current date.

Note It's not compulsory to create a `placeholderEntry` variable, but since you will be using this same object in multiple places, it's a nice idea to create and store the object in a variable.

Now you can update the `placeholder(in:)` method to make it appear like Listing 3-5.

Listing 3-5. placeholder(in:) method

```
func placeholder(in context: Context) -> Match {
      return placeholderEntry
}
```

In Listing 3-5, the `placeholder(in:)` method has been modified to make it return the `placeholderEntry` variable you had declared in Listing 3-4.

getSnapshot(in:completion:)

iOS 14 comes with a widget gallery that displays the previews of the widgets of all the apps in a device. From there, users can choose the widget they want to show in their homescreen. For a widget, the widget gallery is the platform to display its realistic preview and flaunt its beauty and capabilities so that users can come to an informed decision about whether to add it to their homescreen or not.

The `getSnapshot(in:completion:)` method of `TimelineProvider` is what provides widgets the facility of flaunting their preview in the widget gallery, when `context.isPreview` is set to `true`. This method is called whenever the widget is in a transient state like appearing in the widget gallery or waiting for data. So, it's necessary to make sure that this method doesn't contain heavy calculations.

In addition to this, `getSnapshot(in:completion:)` provides a timeline entry representing the current time and state of a widget. So, using this method, you will fetch the latest upcoming match to be displayed in your widget. For that, you will have to fetch the current state of the widget using a new method and perform calculation to get the latest upcoming match. So, in `SmallWidgetDataProvider`, define the `getLatestUpcomingMatch()` method right below the placeholder variable and write the code in Listing 3-6.

Listing 3-6. Definition of the getLatestUpcomingMatch() method

```
func getLatestUpcomingMatch() -> Match {
      if let matches: [Match] = AppUtils.
      fetchDataWith(fileName: "Matches.json") {

            let upcomingMatches = matches.filter({ $0.date >
            Date() })

            let sortedMatches = upcomingMatches.sorted(by: {
            $0.date < $1.date })

            if let firstUpcomingMatch = sortedMatches.first {

                return firstUpcomingMatch
            }
      }

      return placeholderEntry
}
```

Listing 3-6 defines the `getLatestUpcomingMatch()` method, and the following operations take place in it:

1. When you save matches in the app, all of those data are stored in JSON format in a file called **Matches.json**. So, in this step, you are checking if that file exists or not using the `fetchDataWith(filename:)` method of `AppUtils`. One thing to note is that the JSON file could be stored in the document directory of the app. But since more than one target (**SoccerTime** and **SoccerTimeWidget**) needs to access that file, it had to be stored in a container. Hence, to access the file in the container, the `getSharedDocumentsDirectory()` method was created in `AppUtils`, and it has been called by `fetchDataWith(filename:)`. So, if the JSON file exists, then you move forward; else `placeholderEntry` is returned.

Note As you will be using `AppUtils` in your widget extension, make sure to update its **Target Membership** to **SoccerTimeWidgetExtension** as well.

---

2. In step 2, you're filtering the matches with future dates.
3. Now matches are sorted in ascending order on the basis of time. Hence, the match with the date nearest to the current date lies at the first index, and the match with the farthest date stays at last.
4. Finally, the first match from the sorted array of matches is fetched and returned.

Now, update the `getSnapshot(in:completion:)` method as shown in Listing 3-7 to give it the finishing touch.

Listing 3-7. Modification of the getSnapshot(in:completion:) method

```
func getSnapshot(in context: Context, completion: @escaping
(Match) -> Void) {
      completion(getLatestUpcomingMatch())
}
```

Listing 3-7 modifies the `getSnapshot(in:completion:)` method to make it return the nearest upcoming match and, hence, display it in the widget preview shown in the widget gallery. If no upcoming matches have been added in the app, the widget preview displays, "No upcoming matches."

getTimeline(in:completion:)

getTimeline(in:completion:) is the brain of TimelineProvider. It provides an array of timeline entries for the current time and, optionally, any future times to update a widget. Moreover, it sets the timeline reload policy of the widget to user preferred time. The reload policy determines when to update the timeline to refresh the content being displayed in your widget. There are three reload policies that are available:

1. `never`: This policy updates the widget when a new timeline is available.
2. `atEnd`: It requests a new timeline after the date specified in the last timeline passes.
3. `after`: This policy requests a new timeline at a specified date.

The `never` refresh policy can be used in cases when you cannot predict the date for refreshing the widget content. In that situation, WidgetKit doesn't request a new timeline, and when a new timeline becomes available at some point, it calls `reloadTimelines(of Kind:)` of the `WidgetCenter` class. For example, it makes sense to use `never` when a widget's content is dependent on the user being logged in to an account, but they aren't logged in.

But the case is different with `atEnd` and `after`. They are used when future events are predictable and you know when to update the widget's content. To explain this, the official documentation gives an example of a widget displaying stock market details.[1] It says that it is a nice idea to use `atEnd` or `after` in such a scenario because you can specify the next date when the stock market opens or closes since the information generally does not change overnight or during weekends.

Enough of the explanation. Now, modify the `getTimeline(in:completion:)` method as shown in Listing 3-8.

Listing 3-8. Modification of the getTimeline(in:completion:) method

```
func getTimeline(in context: Context, completion: @escaping
(Timeline<Match>) -> Void) {
      // 1
      let entry = getLatestUpcomingMatch()
      // 2
      let refresh = Calendar.current.date(byAdding: .second,
      value: 1, to: entry.date)
```

[1] https://developer.apple.com/documentation/widgetkit/timelineprovider

```
        // 3
        let timeline = Timeline(entries: [entry],
        policy: .after(refresh!))
        // 4
        completion(timeline)
}
```

In the code of Listing 3-8, the following tasks are being done:

1. The nearest upcoming match is fetched using `getLatestUpcomingMatch()`, and the fetched value is stored in entry.
2. Then, the next refresh time is set to be a second later than `entry`'s date.
3. In the third step, a timeline is created with `entry` and an `after` refresh policy. The refresh policy is set to be after the time we set up in step 2.
4. Finally, the timeline is handed over to the widget.

In this way, the configuration of `SmallWidgetDataProvider`, a class conforming to `TimelineProvider`, is complete. Now, it's time to develop the user interface of the widget using SwiftUI.

Developing Your Widget's UI

The last sections were all about configuring the working mechanism of your widget. In this section, you will finally work on the user interface of your widget. You will be making a small-sized widget, and the view you will be creating is basically the same as the one normally made with SwiftUI, but with some small tweaks. The widget will display the logos of the two teams competing in the nearest upcoming match and a countdown before the match begins.

Start by creating a SwiftUI file. Navigate to the **SmallWidget** folder and then create a **SwiftUI View** named **SmallWidgetView** by going to **File ➤ New ➤ File... ➤ SwiftUI View**. After setting the filename and choosing the location, before clicking **Create**, remember to put a checkmark on the **SoccerTimeWidgetExtension** target at the bottom of the dialog box.

After **SmallWidgetView.swift** is created, replace its content by the code given in Listing 3-9.

Listing 3-9. SmallWidgetView.swift

```
// 1
import SwiftUI
import WidgetKit

struct SmallWidgetView: View {
      // 2
      var match: SmallWidgetDataProvider.Entry
      var body: some View {
            // 3
            VStack(alignment: .center) {
            HStack() {
                Club(value: match.primaryClub)
.logo.resizable()
.aspectRatio(contentMode: .fit)
                Text("vs").font(.footnote)
                Club(value: match.secondaryClub)
.logo.resizable()
.aspectRatio(contentMode: .fit)
            }.frame(height: 50)
            if match.date > Date() {
                Text(match.date, style: .timer)
                    .font(.system(.title,
 design: .monospaced))
                          .foregroundColor(Color.gray)
                      .multilineTextAlignment(.center)
            } else {
                Text("No upcoming matches.")
.foregroundColor(.gray)
            }
      }
}
}
```

Listing 3-9 is the code that lays out the user interface of your small-sized widget. However, you must have seen an error saying "Cannot find 'Club' in scope" after pasting the code. To fix this, you need to make `Club` available in the `SoccerTimeWidgetExtension` target, and by now you must have had at least some blurry idea about how to do it. But it's okay if you haven't been able to figure it out yet. Just go to the **Clubs.swift** file and put checkmarks on both **SoccerTime** and **SoccerTimeWidgetExtension** in the Target Membership of File Inspector. Also, do the same and update the target membership of **Assets.xcassets** (located in the **SoccerTime** folder) and **ImageExtension.swift** (located in the **Extension** folder) by checking **SoccerTimeWidgetExtension** to avoid the errors like "Type 'Image' has no member 'alavés'."

Now, let us explain what the code in Listing 3-9 does:

1. Imports SwiftUI and WidgetKit.
2. Declares a variable named `match`, which will be used to provide data to the view. In the current case, the data are `TimelineEntry` values from `SmallWidgetDataProvider`.

3. The view is prepared using VStack and HStack to show the information provided by the match. If the entry's date is not greater than the current time, then "No upcoming matches." is shown instead of a timer.

Till now, the **Canvas** window of **SmallWidgetView** must be saying "No Preview." It is because you removed the preview struct of SmallWidgetView while replacing its content with the code of Listing 3-9. Now, fix it by pasting the code in Listing 3-10 at the bottom of the file.

Listing 3-10. Preview struct of SmallWidgetView

```
struct SmallWidgetView_Previews: PreviewProvider {
    static var previews: some View {
        SmallWidgetView(match: Match(primaryClub: "",
        secondaryClub: "", date: Date()))
     .previewContext(WidgetPreviewContext(family:
      .systemSmall))
    }
}
```

The code in Listing 3-10 creates a preview of `SmallWidgetView`, and as soon as you paste it and click **Resume** in the **Canvas** window, a preview like the one shown in Figure 3-6 is displayed.

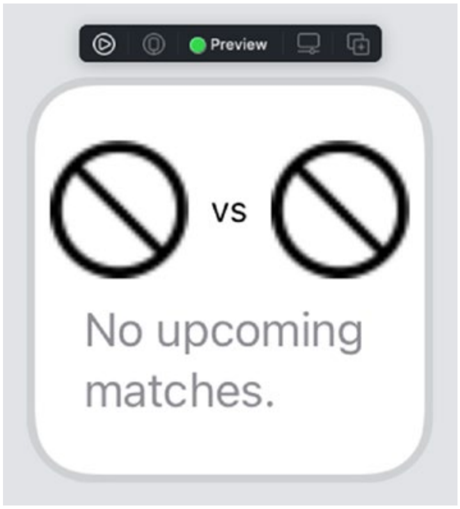


Figure 3-6. *A screenshot displaying the preview of small-sized widget*

WidgetConfiguration

Now it's time to put everything together and make the widget work. For that, you will need to add an entry point, that is, a struct conforming to the `Widget` protocol and marked by the `@main` property wrapper. This struct will contain a body with an instance of `WidgetConfiguration`, and that is where you will join all the pieces together and configure your widget.

To create this entry point, navigate to the **SmallWidget** folder and create a **SwiftUI View** named **SmallWidget** and also make sure you add a checkmark to **SoccerTimeWidgetExtension** in Targets before creating that file. Also, in Targets, if **SoccerTime** is checked, uncheck it.

Tip If you face confusions while creating a SwiftUI View, refer to the second paragraph of "Developing Your Widget's UI" section.

Now, replace the content of **SmallWidget** with the code given in Listing 3-11.

Listing 3-11. SmallWidget.swift

```
import WidgetKit
import SwiftUI

// 1
@main
struct SmallWidget: Widget {
      // 2
      let widgetKind: String = "SmallSoccerTimeWidget"

      // 3
      var body: some WidgetConfiguration {
        StaticConfiguration(kind: widgetKind,
       provider: SmallWidgetDataProvider()) { match
            in
      // 4
            SmallWidgetView(match: match)
        }
      // 5
        .configurationDisplayName("Mini Widget")
        .description("Shows upcoming match.")
        .supportedFamilies([.systemSmall])
    }
}
```

In Listing 3-11, the following things are done:

1. SwiftUI and WidgetKit are imported, and a struct `SmallWidget` conforming to `Widget` is created. Then, `SmallWidget` is marked using the `@main` property wrapper to let the system know that it is the entry point for the target. In other words, the code execution for rendering the small widget starts from here.

2. `widgetKind` is defined using a unique string. It is used to describe your widget.

3. A `Widget`'s body should be an instance of `WidgetConfiguration`. Since both `StaticConfiguration` and `IntentConfiguration` (to be discussed later) conform to `WidgetConfiguration`, any of them can be used. For now, you have used `StaticConfiguration`, providing it `widgetKind` as `kind` and `SmallWidgetDataProvider` as `provider`.

4. In this step, it's been written that `SmallWidgetView` will act as the view of the widget, and it has been provided with a timeline entry, `match`.

5. In the fifth step, a configuration display name and a description have been provided to the widget, and they are displayed above your widget when users see it in the widget gallery. The preview of how the widget looks in the widget gallery is shown in Figure 3-7. Also, since the goal is to just support the small-sized widget, an array containing only the `systemSmall` variety of `WidgetFamily` is passed to the `supportedFamilies()` method.

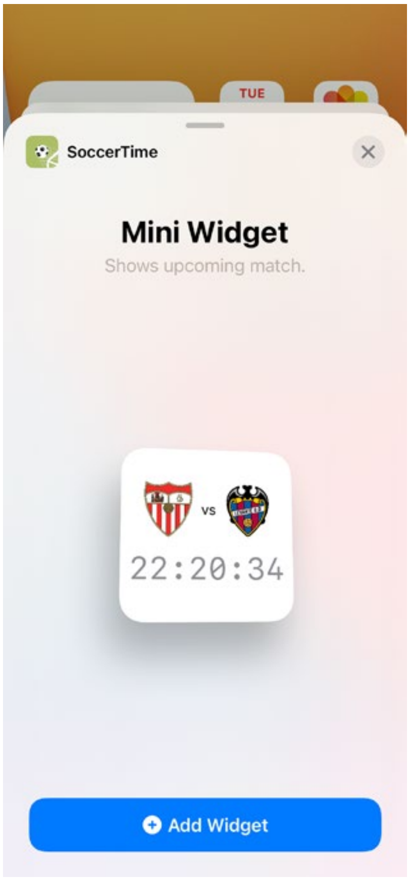


Figure 3-7. *The preview of a small-sized widget of SoccerTime in the widget gallery*

This completes the setup of the widget. Now build and run to see the results of your effort.

Note Before running, make sure that the currently selected scheme is **SoccerTimeWidgetExtension**. For reference, refer to Figure 3-4. If **SoccerTime** is the selected scheme, the app will run, not the widget.

But it doesn't run, does it? This is because there are two entry points for your widget right now. Delete the boilerplate file **SoccerTimeWidget.swift**, created by Xcode when you had first generated the widget extension. Now build and run again.

Now it should run and your simulator should display the small-sized widget in its homescreen, and it should look similar to Figure 3-8.

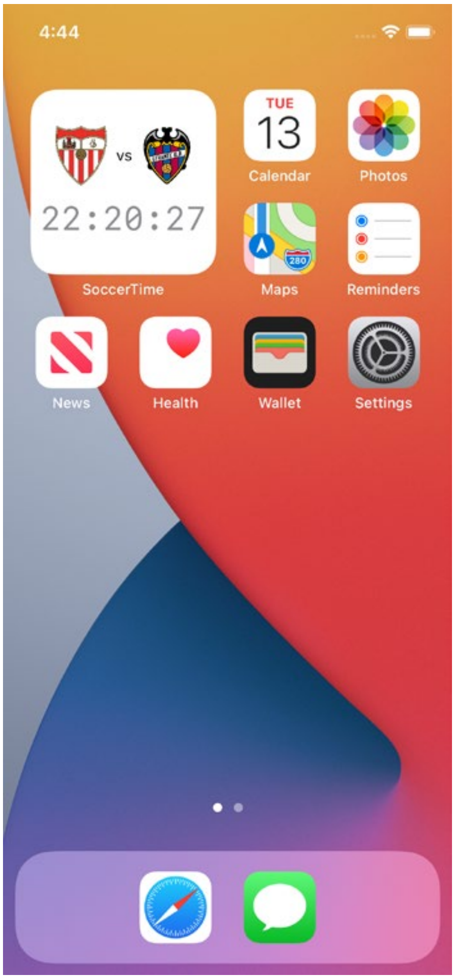


Figure 3-8. *A screenshot of the small-sized widget in the homescreen*

You can play around with the widget and the application. Currently, you may see bugs and limitations, but we will address them one after another in the upcoming chapters.

Summary

Congratulations on making it this far! This might have been a challenging chapter for you, but no matter how hard it was, you made it. By completing this chapter, you have created your very first widget for iOS using SwiftUI. Also, you have gained some familiarity with the building blocks of widgets like timeline, timeline provider, widget view, placeholder, snapshot, and widget configuration. To sum up, a widget is made up of three core components:

1. **Views**: SwiftUI views that are used by WidgetKit as a user interface
2. **TimelineProvider**: A protocol responsible to update the widget content according to the context passed at a specified date
3. **WidgetConfiguration**: Binds all the building blocks of a widget together and configures the widget

You may still have confusions about things, but have patience and practice more. And please refer to the final code of the project in the **SoccerTimeFinal** folder of the **SoccerTime.zip** file. Plus, you don't have to worry as you will use those concepts in the upcoming chapters as well.

The next chapter will teach you about links which will enable users to tap on your widget and navigate to a relevant screen in your app for getting more details about the content shown in your widget. Till then, keep up the good work!

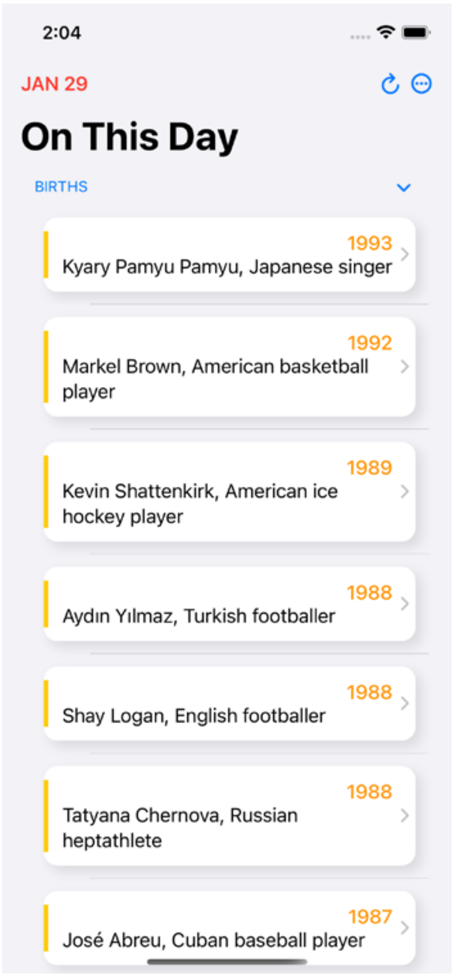
CHAPTER 4

Making Widgets Configurable and Interactive

One special thing about widgets is that users can configure them and also interact with them to some extent. In this chapter, you will learn how you can make your widget configurable and interactive so that users will fall in love with your widget. To make your widget configurable, you will use `IntentConfiguration`. And you will make the views in your widget tappable so that users can tap them and navigate to various screens using deep links. As this chapter has a lot of important things to cover, you may find it longer than other chapters of this book. So, it is a good idea to give this chapter some days and even perform revisions.

Let's Get Started

To begin working, you can unzip the file named **OnThisDay.zip**. If you've successfully unzipped it, open the **OnThisDayStarter** folder and run **OnThisDay.xcodeproj** to see **OnThisDay** in action. OnThisDay is an application that displays the events that historically took place on the system date, by making use of Wikipedia's "On This Day REST API."[1] It lists various types of events like births, deaths, events, holidays, and selected events under their respective section headers. Figures 4-1 and 4-2 give you an idea of how the app actually looks.



2:04

JAN 29

On This Day

BIRTHS

1993
Kyary Pamyu Pamyu, Japanese singer

1992
Markel Brown, American basketball player

1989
Kevin Shattenkirk, American ice hockey player

1988
Aydın Yılmaz, Turkish footballer

1988
Shay Logan, English footballer

1988
Tatyana Chernova, Russian heptathlete

1987
José Abreu, Cuban baseball player

Figure 4-1. *The homescreen of OnThisDay displaying a list of birthdays*

[1] https://en.wikipedia.org/api/rest_v1/#/Feed/onThisDay

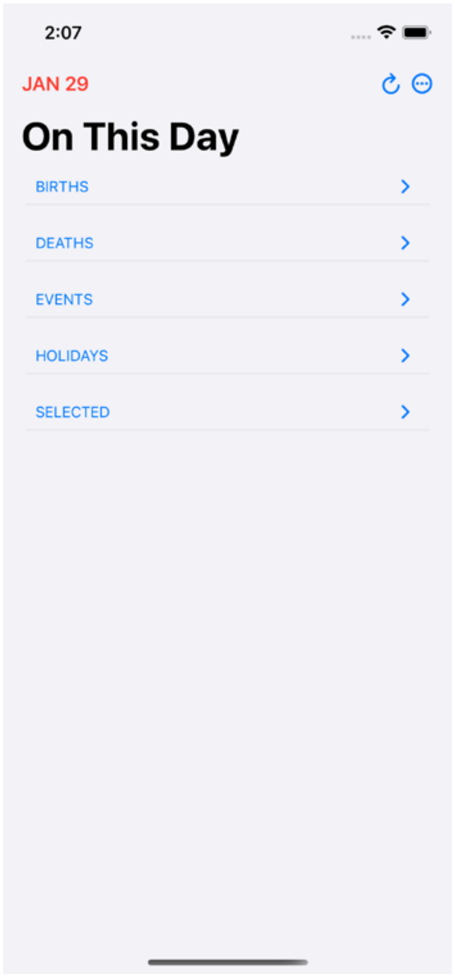
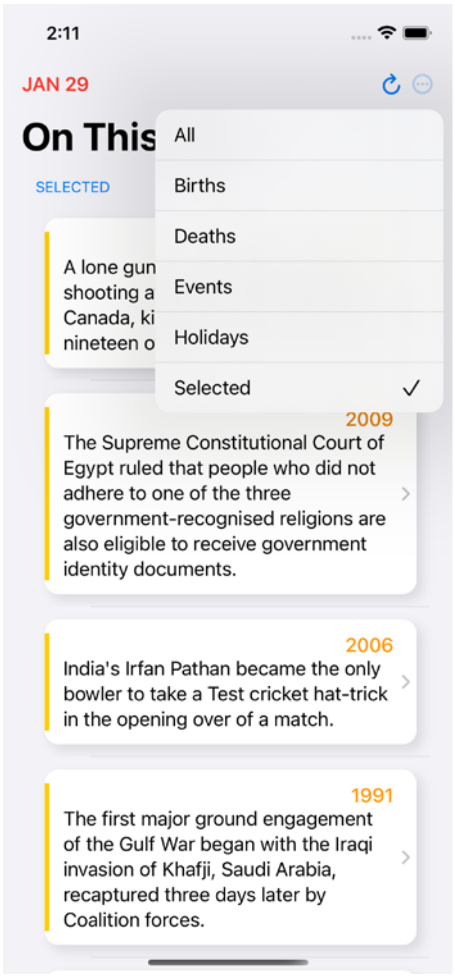


Figure 4-2. *The homescreen of OnThisDay displaying a list of section headers*

Another interesting feature of **OnThisDay** is that you can choose the type of the event and get a filtered list of the events of that particular type. And that choice stays persistent even after you close and rerun the app – meaning that if you choose **Selected** from the menu, even when you close and rerun the app, only **Selected** events will be displayed in the list. Thanks to `UserDefaults`[2] for making this possible! Figure 4-3 displays a menu from which you can select a type or category of events.



A lone gun
shooting a
Canada, ki
nineteen o

2009
The Supreme Constitutional Court of Egypt ruled that people who did not adhere to one of the three government-recognised religions are also eligible to receive government identity documents.

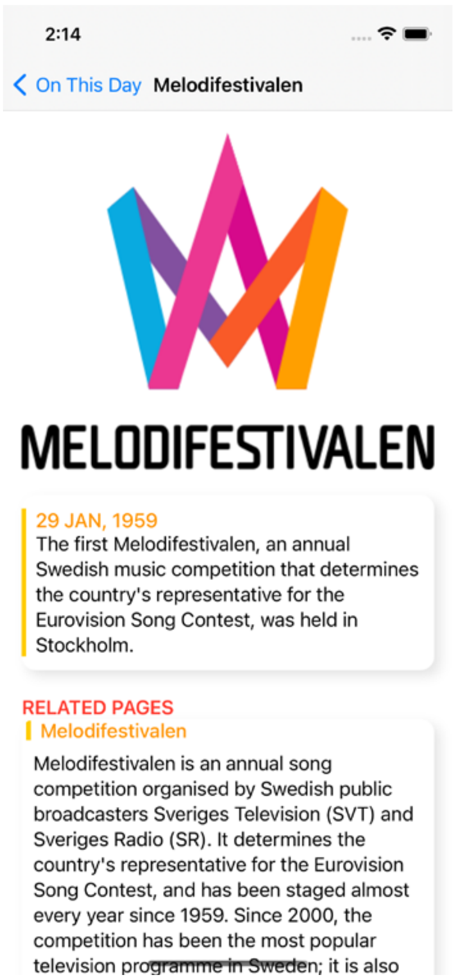
2006
India's Irfan Pathan became the only bowler to take a Test cricket hat-trick in the opening over of a match.

1991
The first major ground engagement of the Gulf War began with the Iraqi invasion of Khafji, Saudi Arabia, recaptured three days later by Coalition forces.

Figure 4-3. *Choosing "Selected" events from the menu*

[2]https://developer.apple.com/documentation/foundation/userdefaults

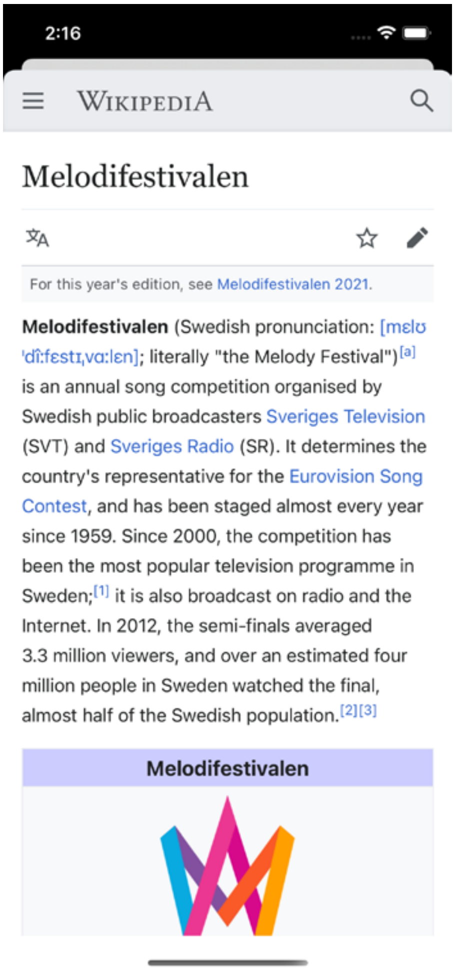
Also, you can tap on an event to see more details and a photo related to that event. Refer to Figure 4-4 to see the screenshot of the event detail screen. **OnThisDay** also shows the pages related to that event, and you can tap on those pages to navigate to their Wikipedia pages. That screen is shown in Figure 4-5.



29 JAN, 1959
The first Melodifestivalen, an annual Swedish music competition that determines the country's representative for the Eurovision Song Contest, was held in Stockholm.

RELATED PAGES
Melodifestivalen
Melodifestivalen is an annual song competition organised by Swedish public broadcasters Sveriges Television (SVT) and Sveriges Radio (SR). It determines the country's representative for the Eurovision Song Contest, and has been staged almost every year since 1959. Since 2000, the competition has been the most popular television programme in Sweden; it is also

Figure 4-4. *A detail screen displayed after tapping an event on the homescreen*



Melodifestivalen

For this year's edition, see Melodifestivalen 2021.

Melodifestivalen (Swedish pronunciation: [mɛlʊ ˈdîːfɛstɪˌvɑːlɛn]; literally "the Melody Festival")[a] is an annual song competition organised by Swedish public broadcasters Sveriges Television (SVT) and Sveriges Radio (SR). It determines the country's representative for the Eurovision Song Contest, and has been staged almost every year since 1959. Since 2000, the competition has been the most popular television programme in Sweden;[1] it is also broadcast on radio and the Internet. In 2012, the semi-finals averaged 3.3 million viewers, and over an estimated four million people in Sweden watched the final, almost half of the Swedish population.[2][3]

Melodifestivalen

Figure 4-5. *A Wikipedia page loaded after tapping a "Related Page" in the detail screen*

Now you must have deduced that **OnThisDay** is a fully functional app. Yes, it is. But, why not create its widgets and display some information on the user's homescreen? Widgets surely can help to make your app look more useful to the user. That is why we have done some part of the work for you. We have already created a widget extension of OnThisDay as **OnThisDayWidgetExtension** and written all three families of widgets for **OnThisDay**. Choose the **OnThisDayWidgetExtension** scheme and run the code to see the small widget of OnThisDay on your simulator's or device's homescreen (Figure 4-6).

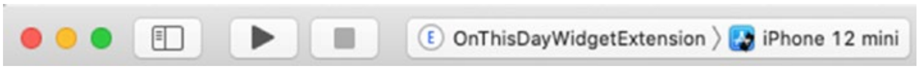


Figure 4-6. *A screenshot displaying OnThisDayWidgetExtension as the selected scheme*

Add the other two widget families also to your homescreen by long pressing a space in the homescreen and tapping the "+" icon. Then from the app list, tap OnThisDay and scroll to your desired widget family and tap **Add Widget**.

Currently, the widgets are displaying dummy data, but later you will integrate Wikipedia's "On This Day REST API" to display updated information.

Now, let's move on to how the widgets look like. The small widget (Figure 4-7), as it has less space, displays only the number of events that took place historically on the system date.

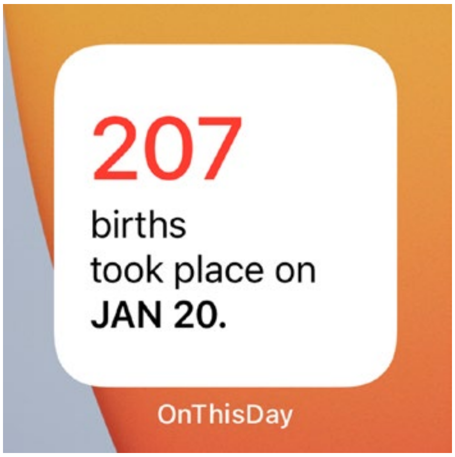


Figure 4-7. *Small-sized widget of OnThisDay*

But since the medium widget (Figure 4-8) can accommodate some more views, it not only shows the number of events that took place historically on the system date but also some information about a couple of events.

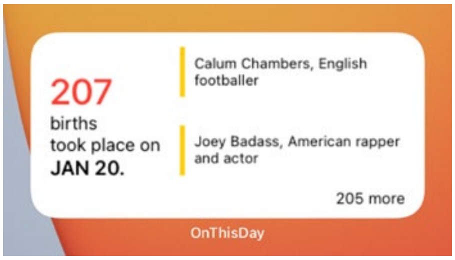

207
births
took place on
JAN 20.
Calum Chambers, English footballer
Joey Badass, American rapper and actor
205 more
OnThisDay

Figure 4-8. *Medium-sized widget of OnThisDay*

And the large widget (Figure 4-9) displays the same information that the medium widget displays, but in a greater amount and a different arrangement.

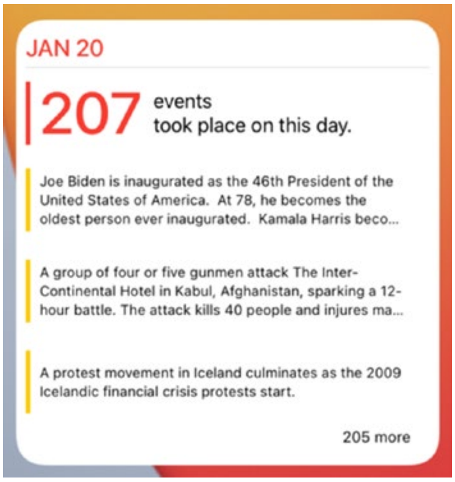

JAN 20
207 events
took place on this day.
Joe Biden is inaugurated as the 46th President of the United States of America. At 78, he becomes the oldest person ever inaugurated. Kamala Harris beco...
A group of four or five gunmen attack The Inter-Continental Hotel in Kabul, Afghanistan, sparking a 12-hour battle. The attack kills 40 people and injures ma...
A protest movement in Iceland culminates as the 2009 Icelandic financial crisis protests start.
205 more

Figure 4-9. *Large-sized widget of OnThisDay*

In addition to this, at the later part of this chapter, you will make your widgets configurable – meaning that users will be able to long press on your widgets and **Edit Widget** to select the type/category of events whose information they would like the widget to display. Hence, if the users select **Holidays**, only the information of the events lying in the "Holidays" category will be displayed in the widget. Figure 4-10 is the screenshot of the widget displaying the list of options given when a widget is long pressed, and Figure 4-11 is the screenshot of the widget displaying the configuration option shown after tapping **Edit Widget**. In addition to these, Figure 4-12 shows the event categories that users can choose from to make their widget display information about.

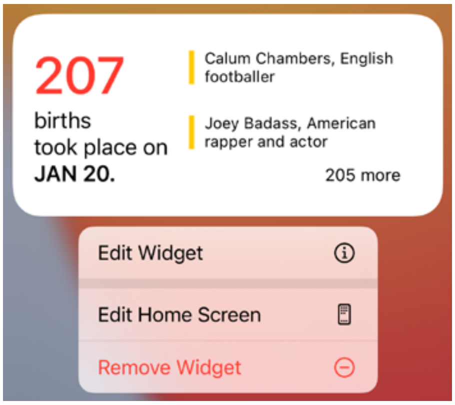


Figure 4-10. *The list of options displayed when a widget is long pressed*

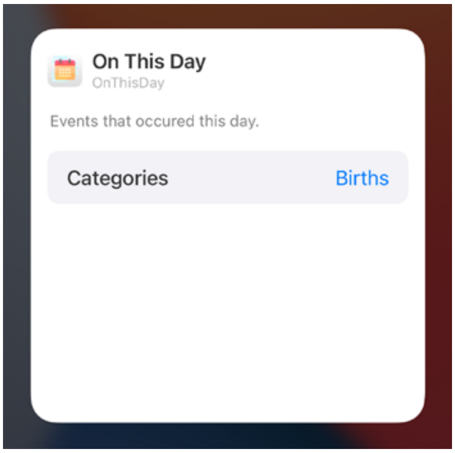


Figure 4-11. *The configuration option displayed after tapping Edit Widget in Figure 4-10*

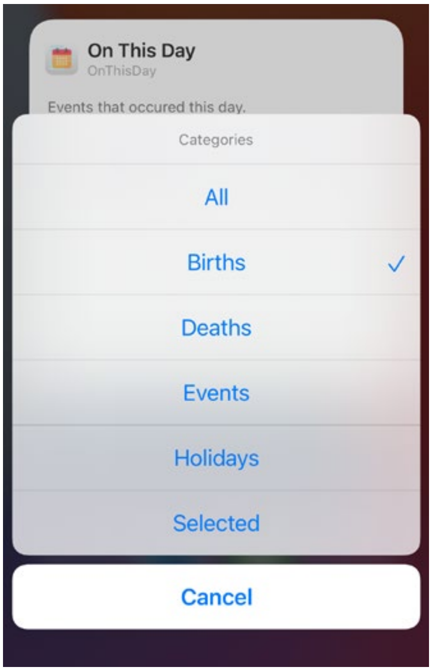


Figure 4-12. *The event categories users can choose from to make the widget display information about*

Now, it's time that you look at the already existing code. As we have already stated earlier, we have already set up some basic stuff.

If you go to the **Project Navigator** and open the **OnThisDay** project, you will find two main folders, that is, **OnThisDay** and **OnThisDayWidget**. The **OnThisDay** folder contains the files and folders related to the app, and the **OnThisDayWidget** folder contains the files and folders related to the widgets. There are also certain files which are used by both the app and the widgets, and those files are shared using **Target Membership**.

Open the **OnThisDay** folder in the **OnThisDay** project to see the following folder structure:

```
OnThisDay
├── Assets.xcassets
├── Extensions
│   ├── URL.swift
│   └── View.swift
├── Info.plist
├── Models
│   ├── ContentURL.swift
│   ├── EventData.swift
│   ├── EventType.swift
│   ├── OTDResponse.swift
│   ├── OriginalImage.swift
│   ├── Page.swift
│   └── URLData.swift
├── OnThisDayApp.swift
├── Preview\ Content
├── Utilities
│   ├── DateHelper.swift
│   └── WebView.swift
├── ViewModels
│   └── OTDViewModel.swift
│
```

```
└── Views
    ├── Custom\ Views
    │   ├── DetailRowView.swift
    │   ├── HomeRowView.swift
    │   ├── RelatedPageRowView.swift
    │   └── TrailingNavView.swift
    ├── DetailView.swift
    └── HomeView.swift
```

You will see **Assets.xcassets** and **Info.plist** in that folder. Likewise, there is a folder called **Extensions** that stores the extensions of various structs.

In addition to these, there is a **Models** folder that contains the files used to parse the response data received after calling Wikipedia's API endpoint.

OnThisDayApp.swift is the main entry point of your app, and the **Preview Content** folder is a folder generated by Xcode to store the assets used for development purposes. The files in this folder are not included by Xcode in release builds.

There is a **Utilities** folder, and it contains various utilities used by the app for serving purposes like working with dates and loading webview.

And the **ViewModel** folder contains **OTDViewModel.swift**, the view model for the app.

Finally, the **Views** folder contains a number of files and folders. There are various small views stored in the **Custom Views** folder, and those views are used by **HomeView.swift** and **DetailView.swift**, which contain the user interface of the app.

That's the description of the folder and files in the **OnThisDay** folder.

Now, open the **OnThisDayWidget** folder to see the following folder structure:

```
OnThisDayWidget
├── Assets.xcassets
├── Info.plist
├── Model
│   └── WidgetEventData.swift
├── Provider
│   └── Provider.swift
├── Views
│   ├── LargeWidgetView.swift
│   ├── MediumWidgetView.swift
│   ├── SmallWidgetView.swift
│   └── WidgetView.swift
└── Widget
    └── OnThisDayWidget.swift
```

Other than the **Assets.xcassets** folder and **Info.plist** file, you will see a folder called **Model** that contains **WidgetEventData.swift**. This model contains a `TimelineEntry` called `WidgetEvent` which is vital for your widgets to work.

Likewise, there is a folder called **Provider** containing **Provider.swift**, which is the `TimelineProvider` of the widgets. If you remember, it is what drives a widget by fetching `TimelineEntry` values.

The next folder that you can see is **Views**, and it contains **LargeWidgetView.swift**, **MediumWidgetView.swift**, **SmallWidgetView.swift**, and **WidgetView.swift**. Those files contain the user interface of your widgets. The **WidgetView.swift** file is the main file that determines which view should be rendered when a particular widget family is chosen by users.

And lastly, the Widget folder contains the **OnThisDayWidget.swift** file, which is the entry point for the **OnThisDayWidgetExtension** target. It is currently using `StaticConfiguration`, which you will replace with `IntentConfiguration` to make your widgets configurable.

Giving Widgets the Power to Talk to API

In this section, you will remove dummy data from your widgets and give them the capability to call Wikipedia's "On This Day API" to fetch fresh data and to display latest information. For now, do not worry about the categories/types of events as you will make your widget fetch and display information about all types of events.

1. Create a new file named **OnThisDayAPI.swift** in the **Provider** folder of **OnThisDayWidget**. Make sure that the **OnThisDayWidgetExtension** target is checked along with the **OnThisDay** target while creating this file.

2. Copy and paste the code in Listing 4-1 to that file to create an `OnThisDayAPI` struct with a static `fetchOnThisDayData(with:)` method.

Listing 4-1. OnThisDayAPI struct with a static method to call Wikipedia's API

```
struct OnThisDayAPI {
    static func fetchOnThisDayData(with completion: @escaping
    ([WidgetEventData]) -> Void) {
        guard let today = DateHelper.getDayAndMonthInNumbers(),
              let url = URL(string: "https://en.wikipedia.org/
              api/rest_v1/feed/onthisday/all/\(today.month)/
              \(today.day)") else { return }
        let task = URLSession.shared.dataTask(with: url) {
        data, response, _ in
            if let data = data,
               let response = response as? HTTPURLResponse,
               response.statusCode == 200 {
                do {
                    let otdResponse = try JSONDecoder().
                    decode(OTDResponse.self, from: data)
                    var responses: [EventData] = []
                    responses = otdResponse.selected +
                    otdResponse.births + otdResponse.deaths +
                    otdResponse.events + otdResponse.holidays
                    completion(responses.map({ WidgetEventData
                    (text: $0.text) }))
                } catch {
                    completion([])
                    print("JSON Decoding Error.")
                }
                completion([])
            }
        }
        task.resume()
    }
}
```

Listing 4-1 consists of the `OnThisDayAPI` struct that contains a static method named `fetchOnThisDayData(with:)`. This method calls Wikipedia's API to fetch all types of events that took place on the system date that is returned by the `DateHelper.getDayAndMonthInNumbers()` method and stored in the `today` variable. Then the response is decoded, and it is returned to the caller using its completion handler that takes an array of `WidgetEventData` as an argument.

Now, since you have `fetchOnThisDayData(with:)` ready, it's time to call it. Go to **Provider.swift** and replace `getTimeline(in:completion:)` with the code given in Listing 4-2.

Listing 4-2. getTimeline(in:completion:) method that performs an API call by calling fetchOnThisDayData(with:)

```
func getTimeline(in context: Context, completion: @escaping
(Timeline<Entry>) -> Void) {
     // 1
    OnThisDayAPI.fetchOnThisDayData { widgetData in
     // 2
            let currentDate = Date()
     // 3
            let refreshDate = Calendar.current.date(byAdding:
            .day, value: 1, to: currentDate)!
     // 4
            let entry = WidgetEvent(date: currentDate, events:
            widgetData)
     // 5
            let timeline = Timeline(entries: [entry], policy:
            .after(refreshDate))
     // 6
            completion(timeline)
     }
}
```

In the code of Listing 4-2, the following things are happening:

1. The static `fetchOnThisDayData(with:)` method of the `OnThisDayAPI` struct is called.

2. As soon as the completion handler of `fetchOnThisDayData(with:)` returns the results as `widgetData`, the current date is stored in `currentDate`.

3. Now the date of the next day is stored in `refreshDate`. It will be used later to set up the widget's refresh policy.

4. Since a widget depends upon timeline entries to create a timeline, a `WidgetEvent` timeline entry is created and stored in `entry`. And the values of `currentDate` and `widgetData`, received as the response of the API call, are passed to the `WidgetEvent` constructor.

5. As there is at least one timeline entry, it's time to create a timeline. So, a timeline is created and stored in `timeline` by passing an array containing `entry`. Also, the refresh policy is set to make the widget request new timeline after `refreshDate`. In this way, the widget is set to refresh everyday.

Now, select the **OnThisDayWidgetExtension** scheme (if you haven't selected it) and run the code to see your widgets fetching data from Wikipedia's API. Right now, your widgets will display information about all the events (and not an event of a certain category). Initially, the widget(s) may take some time before loading updated data. So, have some patience and enjoy your achievement. Your small, medium, and large widgets should look similar to Figures 4-7, 4-8, and 4-9, respectively.

You have successfully given your widgets the capability to load event information from an API. Well done! But events can lie in different categories, and users may want information related to a particular event category only. In the upcoming section, you will add the feature to allow users to configure your widgets to display information related only to a certain category.

Allowing Users to Configure Widgets

This section will be about making your widgets configurable. Right now, your widgets are displaying event information regardless of their categories. But maybe some users would love to configure their widgets in such a way that they get information only about a specific category of events. Maybe someone would like to keep track of birthdays of historical personalities, or maybe someone likes to get information about special historical events that took place. To serve that purpose, you can develop your widgets in such a way that users can select their preferred event category and configure them to show information related to that particular event category.

Now this is where `IntentConfiguration` comes into play. Till now, you have used `StaticConfiguration` only because you did not need to allow your users to configure widgets according to their preferences. If you do not remember where you had used `StaticConfiguration`, open the **OnThisDayWidget** folder. There, you will see a folder called **Widget**. Open it to find **OnThisDayWidget.swift**, which is the entry point of your widgets. This is where you have created a `StaticConfiguration`. In **OnThisDayWidget.swift**, you should see a block of code similar to Listing 4-3.

Listing 4-3. The StaticConfiguration in OnThisDayWidget.swift

```
var staticConfiguration: some WidgetConfiguration {
        StaticConfiguration(kind: kind, provider: Provider()) {
        entry in
            WidgetView(events: entry.events)
        }
        .supportedFamilies([.systemSmall, .systemMedium,
        .systemLarge])
        .configurationDisplayName("On This Day")
        .description("Events that occured this day.")
    }
```

You will change this configuration to `IntentConfiguration` and make some other changes in some time to make your widgets configurable. Now it's time to get to work by following the given steps.

Create and Configure a SiriKit Intent Definition File

Firstly, you will create an intent definition file since it will allow you to define customizable or configurable properties for your widgets. For creating that file and configuring it, follow the steps given as follows:

1. Right-click the **OnThisDayWidget** folder in your project and click **New File...**.

2. In the dialog box that appears, select **SiriKit Intent Definition File**, name it **EventCategory.intentdefinition**, and create the file. While creating the file, make sure that both **OnThisDayWidgetExtension** and **OnThisDay** targets are checked at the bottom of the dialog

box. If you do not check the **OnThisDay** target while creating this file, your configuration options (category selection field in your case) will not appear in the configuration screen of your widgets.

3. Now, open **EventCategory.intentdefinition**. Click the "+" icon at the bottom left of the intent file, and from the list of options, click **New Intent** (Figure 4-13).

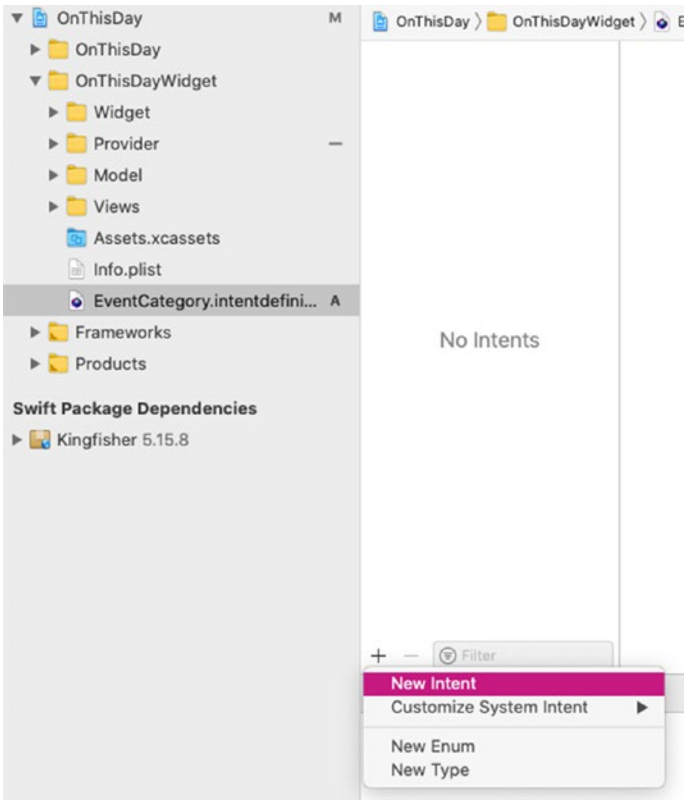


Figure 4-13. *Creating a new intent in the intent definition file*

4. Give your intent the name **EventCategory**. Then, go to the right side of the file and set the **Category** to **View**.

5. Since you are going to use the intent for widgets only, put a checkmark on **Intent is eligible for widgets** and remove checkmarks from **Intent is user-configurable in the Shortcuts app and Add to Siri** and **Intent is eligible for Siri Suggestions**.

6. Now, add a parameter named **categories** in the **Parameters** section by clicking the "+" button below it. The parameters added in the **Parameters** section are the configurable properties that users will see and interact with in the configuration screen of the widget. As you complete typing the name, you will see the display name set to **Categories**. The display name is displayed in the configuration screen of the widget (Figure 4-11).

7. Then change the type of the **categories** parameter to **Add Enum...** as you would like to display a list of selectable categories to the user in the widget configuration screen displayed in Figures 4-11 and 4-12. For your ease, this step is shown in Figure 4-14.

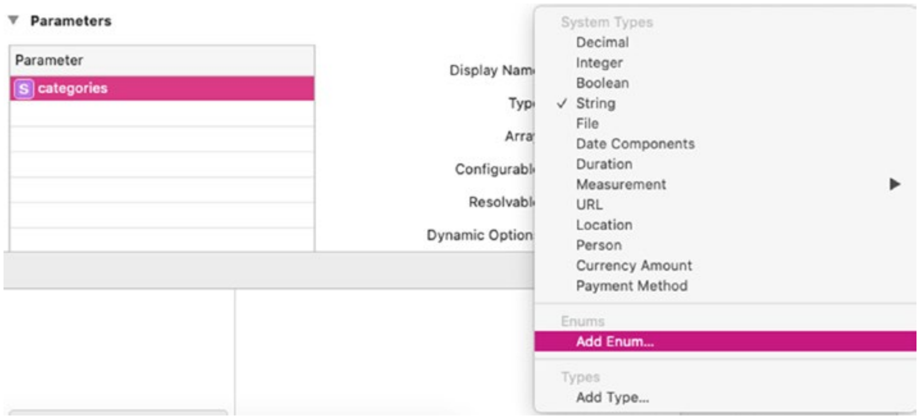


Figure 4-14. *Creating a parameter called "categories" and changing its "Type" to "Add Enum..."*

8. After clicking **Add Enum...**, a new screen is displayed that looks like Figure 4-15. Then, change the name of the enum to **Categories** by typing it in the item under the **ENUMS** header at the left.

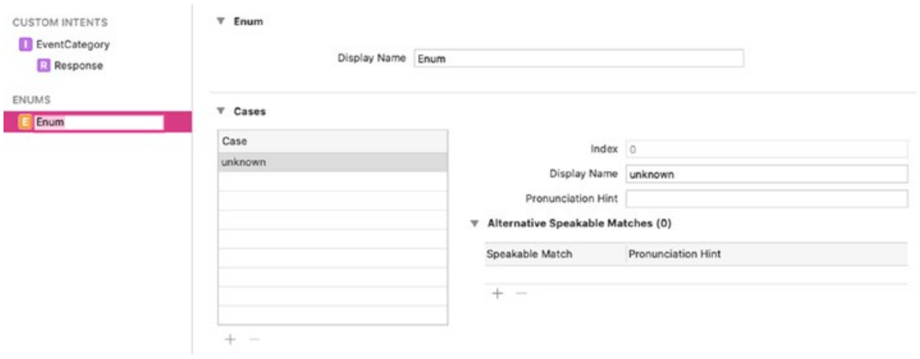
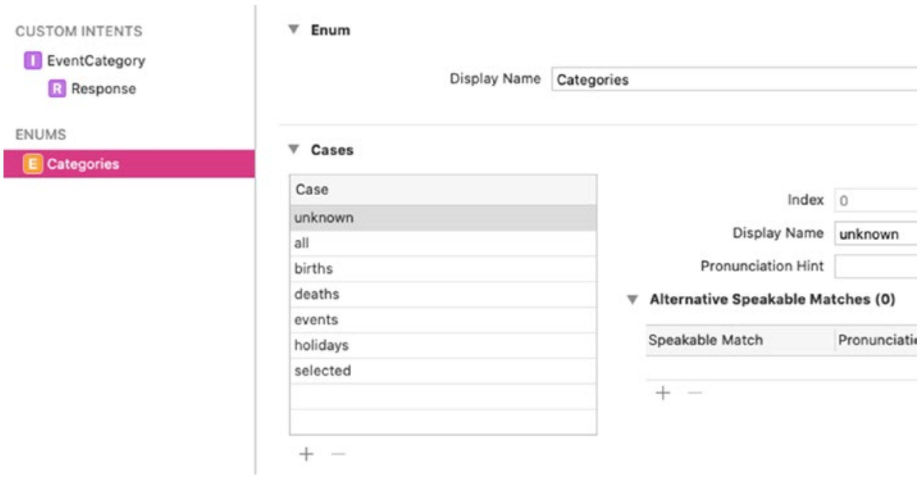


Figure 4-15. *The screen shown after clicking "Add Enum..."*

9. Now, go back to the **EventCategory** custom intent and select the **categories** parameter. Then, remove the checkmark from **Siri can ask for value when run**, as we do not want to work with Siri.

10. Again, open the **Categories** enum shown below the **ENUMS** header. Now it's time to add cases by clicking the "+" icon below the **Cases** section. Set the names of the cases to **all**, **births**, **deaths**, **events**, **holidays**, and **selected** and their display names to **All**, **Births**, **Deaths**, **Events**, **Holidays**, and **Selected**, respectively. These display names are shown to users in the configuration screen (Figure 4-12). If you have noticed the index of each case, you will see that the index of **unknown** is set as 0, and it cannot be modified. But, the indices of other cases are set in a numerical order, and Xcode allows you to modify them. At the end, your enum will look like Figure 4-16.



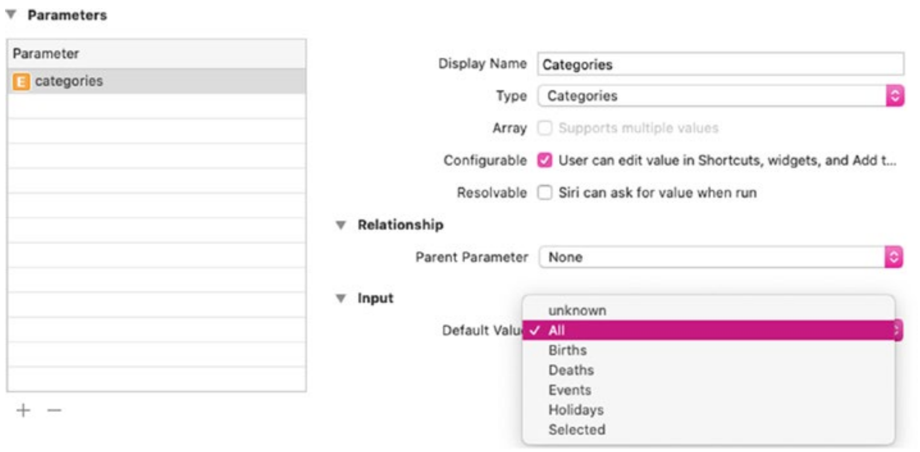
Display Name: Categories

Case
unknown
all
births
deaths
events
holidays
selected

Index: 0
Display Name: unknown
Pronunciation Hint:

***Figure 4-16.** The final look of the Categories enum*

11. Now for the final step, open the **EventCategory** custom intent and select the **categories** parameter in the **Parameters** section to see its configuration. Under the **Input** section at the right side of the window, set **Default Value** to **All** so that your widget displays information about all categories of events in case users do not ever configure your widgets to get information related to a certain category of events (Figure 4-17).


Parameters

Parameter
categories

Display Name: Categories
Type: Categories
Array: Supports multiple values
Configurable: ✓ User can edit value in Shortcuts, widgets, and Add t...
Resolvable: Siri can ask for value when run

Relationship

Parent Parameter: None

Input

Default Valu ✓ All

Figure 4-17. *Setting the "Default Value" of "categories" to "All."*

Like this, you have completed creating and setting up your intent definition file. Congratulations! You are now one step closer to making your widget configurable.

Switch to IntentConfiguration

As mentioned previously, you had used `StaticConfiguration` till now because there was no need to make your widgets user configurable. But now, you want to make them user configurable, and you have already completed the first step of the setup. Now, it's time to switch to `IntentConfiguration`. For that, you will have to follow the given steps:

1. Right-click the **Provider** folder of the **OnThisDayWidget** folder, click **New File...**, and create a new Swift file named **IntentProvider.swift**. Make sure the **OnThisDayWidgetExtension** target is checked at the bottom of the dialog box before creating the file.

Note You could use the existing **Provider.swift** file instead of creating **IntentProvider.swift**, but for better clarity, we recommend you to create **IntentProvider.swift**.

---

2. Open the **IntentProvider.swift** file and replace the existing code content with the code given in Listing 4-4.

Listing 4-4. Creating IntentProvider that conforms to IntentTimelineProvider

```
import SwiftUI
import WidgetKit

struct IntentProvider: IntentTimelineProvider {

}
```

3. In Listing 4-4, a struct named `IntentProvider` that conforms to `IntentTimelineProvider` is created. As soon as you add the code, Xcode will ask if you want to add protocol stubs. Click **Fix** and add them to see two typealiases, `Entry` and `Intent`, added to the struct.

4. In the `IntentProvider` struct, replace the `type` placeholder of `Entry` with `WidgetEvent`, a timeline entry type. Also, replace the `type` placeholder of `Intent` with `EventCategoryIntent`. The name `EventCategoryIntent` was generated from the custom intent, `EventCategory`, you had previously created in your intent definition file, that is, **EventCategory.intentdefinition**.

Tip While replacing the `type` placeholder of `Intent` with `EventCategoryIntent` in `IntentProvider`, it would be a better idea to type `EventCategoryIntent` yourself to check if Xcode gives the autocompletion or not. It can help you verify if `EventCategoryIntent` has been generated by Xcode or not.

Now your code should look similar to the code in Listing 4-5.

Listing 4-5. IntentProvider after adding Entry and Intent types

```
import SwiftUI
import WidgetKit

struct IntentProvider: IntentTimelineProvider {
  typealias Entry = WidgetEvent
  typealias Intent = EventCategoryIntent
}
```

5. Still Xcode must be asking you to add protocol stubs. Add them too to find `placeholder(in:)`, `getSnapshot (for:in:completion:)`, and `getTimeline(for:in: completion:)` methods generated.

6. For now, you can fill up those methods by copying and pasting code from the methods in **Provider. swift** to make `IntentProvider` look like Listing 4-6.

Note Keep in mind that the methods in `IntentProvider` are different from those in `Provider`. `Provider` has methods like `getSnapshot(in:completion:)` and `getTimeline(in:completion:)`, but `IntentProvider` has methods like `getSnapshot(for:in:completion:)` and `getTimeline(for:in:completion:)`.

So, while copying code from `Provider`, make sure that you do not copy the whole methods but only the lines within the braces of those methods. For ease, you can copy the code from Listing 4-6.

Listing 4-6. IntentProvider after implementing required methods

```
import SwiftUI
import WidgetKit

struct IntentProvider: IntentTimelineProvider {
  typealias Entry = WidgetEvent

  typealias Intent = EventCategoryIntent
  func placeholder(in context: Context) -> WidgetEvent {
    WidgetEvent(date: Date(), events: WidgetEventData.events)
  }

  func getSnapshot(for configuration: EventCategoryIntent, in
  context: Context, completion: @escaping (WidgetEvent) ->
  Void) {
    let entry = WidgetEvent(date: Date(), events:
    WidgetEventData.events)
    completion(entry)
  }

  func getTimeline(for configuration: EventCategoryIntent,
  in context: Context, completion: @escaping
  (Timeline<WidgetEvent>) -> Void) {
    OnThisDayAPI.fetchOnThisDayData { widgetData in
      let currentDate = Date()
      let refreshDate = Calendar.current.date(byAdding: .day,
      value: 1, to: currentDate)!
      let entry = WidgetEvent(date: currentDate, events:
      widgetData)
      let timeline = Timeline(entries: [entry], policy:
      .after(refreshDate))
      completion(timeline)
    }
  }
}
```

7. Since it's necessary for the timeline entries in your widget to know the selected event category, you need to modify your timeline entry model. Navigate to **WidgetEventData.swift** in **Model** and add a new property, `category`, of the `Categories`

type to the `WidgetEvent` struct. `Categories` is the enum that you had defined in **EventCategory.intentdefinition**. Also, set its value to `.all` to make it the default selected category. Now, `WidgetEvent` should look similar to Listing 4-7.

Listing 4-7. WidgetEvent struct after adding the category property

```
struct WidgetEvent: TimelineEntry {
  var date: Date
  var events: [WidgetEventData]
  var category: Categories = .all
}
```

8. Now go back to **IntentProvider.swift**. The implementations of `placeholder(in:)` and `getSnapshot(for:in:completion:)` do not need to be modified, except that of `getTimeline(for:in:completion:)`.

   The configuration parameter in `getTimeline(for:in:completion:)` stores all the widget configuration values set by users. Hence, it also holds the category value set by users. This category value needs to be passed to each timeline entry so that the widget can fetch the event data related to a specific event category. You can pass the category value to each timeline entry by using the `category` property you just added in `WidgetEvent` in step 7. If you see the implementation of `getTimeline(for:in:completion:)`, you can find the line shown in Listing 4-8.

Listing 4-8. The line in getTimeline(for:in:completion:) that creates a WidgetEvent timeline entry

```
let entry = WidgetEvent(date: currentDate, events: widgetData)
```

Listing 4-8 shows the line of code in `getTimeline (for:in:completion:)` that creates a `WidgetEvent` timeline entry and stores it into `entry`. Now, replace that line with the line given in Listing 4-9.

Listing 4-9. Creation of a WidgetEvent timeline entry that takes the category as an argument

```
      let entry = WidgetEvent(date: currentDate, events:
      widgetData, category: configuration.categories)
```

Listing 4-9 creates a `WidgetEvent` timeline entry that takes the category from configuration data as an argument. This completes the setup of `IntentProvider`.

9. In this step, you will finally use the `IntentProvider` you just configured. Open **OnThisDayWidget.swift** in the **Widget** folder and replace the body of `OnThisDayWidget` with the code in Listing 4-10.

Listing 4-10. OnThisDayWidget's body using IntentConfiguration

```
var body: some WidgetConfiguration {
    IntentConfiguration(kind: kind,
                        intent: EventCategoryIntent.self,
                        provider: IntentProvider()) { entry in
      WidgetView(events: entry.events)
    }
    .supportedFamilies([.systemSmall, .systemMedium,
    .systemLarge])
    .configurationDisplayName("On This Day")
    .description("Events that occured this day.")
  }
```

If you look at the code in Listing 4-10, you will see that the body of `OnThisDayWidget` has an `IntentConfiguration` initializer instead of a `StaticConfiguration` initializer. The only difference between those initializers is that `IntentConfiguration` takes an argument, `intent`, with the value, `EventCategoryIntent.self` (you had created this custom intent in `EventCategory.intentdefinition`), and another argument, `provider`, with an initializer of `IntentProvider`. All the other codes are identical to that of the `StaticConfiguration` initializer that was previously being used. Also, delete the `staticConfiguration` variable as you will not need it anymore.

Like this, you have completed switching to `IntentConfiguration` from `StaticConfiguration`. Now it's time to make the API call and display the result in the views.

Talk to the API and Display Fresh Information in Widgets

If you open **OnThisDayAPI.swift**, the file that contains the `OnThisDayAPI` struct responsible to perform API calls, and study its static `fetchOnThisDayData(with:)` method, you will see that no work has been done to fetch and return data according to a selected event category. It just performs an API call to Wikipedia's REST API endpoint, which returns data related to various categories of events under different keys. Then, the method stores those data of each and every category in a variable called `response` and returns it. Hence, currently, the method is returning only the results of the `all` category. Let's modify this method so that it is able to filter and return events lying in categories other than `all` too. Replace the `fetchOnThisDayData(with:)` method with the code given in Listing 4-11.

Listing 4-11. fetchOnThisDayData(for:completion:) method

```
static func fetchOnThisDayData(for type: Categories,
completion: @escaping ([WidgetEventData]?) -> Void) {
  guard let today = DateHelper.getDayAndMonthInNumbers(),
        let url = URL(string: "https://en.wikipedia.org/api/
        rest_v1/feed/onthisday/all/\(today.month)/\(today.
        day)") else { return }
  let task = URLSession.shared.dataTask(with: url) { data,
  response, _ in
    if let data = data,
       let response = response as? HTTPURLResponse,
       response.statusCode == 200 {
      do {
        let otdResponse = try JSONDecoder().decode(
        OTDResponse.self, from: data)
        var responses: [EventData] = []
        switch type {
        case .births: responses = otdResponse.births
        case .deaths: responses = otdResponse.deaths
        case .events: responses = otdResponse.events
        case .holidays: responses = otdResponse.holidays
        case .selected: responses = otdResponse.selected
        default: responses = otdResponse.selected
```

```
 + otdResponse.births + otdResponse.deaths + otdResponse.events
 + otdResponse.holidays
        }
        completion(responses.map({ WidgetEventData(text:
        $0.text) }))
      } catch {
        completion(nil)
        print("JSON Decoding Error.")
      }
    }
  }
  task.resume()
}
```

Listing 4-11 is the code that replaces the old `fetchOnThisDayData(with:)` method. This new method `fetchOnThisDayData(for:completion:)`, in addition to the completion handler, has a new parameter named `for` of type `Categories`. This `for` parameter plays an important role in filtering the data according to the selected category. It is visible in the `switch` case used in the code. A `switch` case is applied on the `type` variable (previously `for` variable), and only the results of a particular category are returned by the method as long as other categories, except the default category `all`, are selected. For example, if the selected `type`/category is `births`, the method will return only the data held by the `births` key of the API response.

Now build the code to see the locations affected by this change. The first location affected is **Provider.swift**. Since the struct in this file was being used by `StaticConfiguration` and now you are no longer using `StaticConfiguration`, delete **Provider.swift**. After that, the only affected area remaining will be **IntentProvider.swift**. Xcode must be saying, “Missing argument for parameter ‘for’ in call.” Click **Fix** to make Xcode add the necessary argument `for`. And replace the placeholder with `configuration.categories` to fetch the selected category from your widget's configuration. Now your call to the `fetchOnThisDayData(for: completion:)` method in `getTimeline(for:in:completion:)` should look something like Listing 4-12.

Listing 4-12. fetchOnThisDayData(for:completion:) method after fetching categories from the widget's configuration

```
func getTimeline(for configuration: EventCategoryIntent, in
context: Context, completion: @escaping (Timeline<WidgetEvent>)
-> Void) {
    OnThisDayAPI.fetchOnThisDayData(for: configuration.
    categories) { widgetData in
      let currentDate = Date()
      let refreshDate = Calendar.current.date(byAdding: .day,
      value: 1, to: currentDate)!
      let entry = WidgetEvent(date: currentDate, events:
      widgetData, category: configuration.categories)
      let timeline = Timeline(entries: [entry], policy:
      .after(refreshDate))
      completion(timeline)
    }
  }
```

Still, you must be seeing another error message from Xcode. This time, it must be saying, "Value of optional type '[WidgetEventData]?' must be unwrapped to a value of type '[WidgetEventData]'." To get rid of this, use `guard-let` to unwrap the optional `widgetData` value received from the `fetchOnThisDayData(for:completion:)` method's completion handler. After using `guard-let`, the function call of `fetchOnThisDayData(for: completion:)` in `getTimeline(for:in:completion:)` should look like Listing 4-13.

Listing 4-13. fetchOnThisDayData(for:completion:) method unwrapping widgetData using guard-let

```
func getTimeline(for configuration: EventCategoryIntent, in
context: Context, completion: @escaping (Timeline<WidgetEvent>)
-> Void) {
    OnThisDayAPI.fetchOnThisDayData(for: configuration.
    categories) { widgetData in
      guard let widgetData = widgetData else { return }
      let currentDate = Date()
      let refreshDate = Calendar.current.date(byAdding: .day,
      value: 1, to: currentDate)!
      let entry = WidgetEvent(date: currentDate, events:
      widgetData, category: configuration.categories)
      let timeline = Timeline(entries: [entry], policy:
      .after(refreshDate))
      completion(timeline)
    }
  }
```

After using `guard-let` to unwrap `widgetData` as shown in Listing 4-13, the error message should be gone. Build your project to verify it.

Now there is one more thing remaining, that is, setting up the widget views to display the selected category. If you take a look at how the widgets look, you will see that there is a text that says, "200 births took place on JAN 20.", if the selected event category is `births`, the date is January 20, and the number of events in the `births` category is 200. So, let's set up the view.

Start setting up the view by adding the line of code given in Listing 4-14 in `WidgetView`, `SmallWidgetView`, `MediumWidgetView`, and `LargeWidgetView`.

Listing 4-14. Creating a variable “category” of Categories type

```
var category: Categories
```

As soon as you complete creating that variable in all views, you will see errors in the previews of `SmallWidgetView`, `MediumWidgetView`, and `LargeWidgetView` since the argument for parameter `category` has not been passed in the previews. Click **Fix** to add the `category` parameter and set the argument to `.all`. For example, in the case of `SmallWidgetView`, something like Listing 4-15 can be done.

Listing 4-15. Fixing the preview of SmallWidgetView by passing a category

```
struct SmallWidget_Previews: PreviewProvider {
    static var previews: some View {
      SmallWidgetView(eventCount: 5, category: .all)
            .previewContext(WidgetPreviewContext(family:
            .systemSmall))
    }
}
```

Pass a `category` argument in the previews of `MediumWidgetView` and `LargeWidgetView` to get rid of the error messages.

Now, if you build the project, you will still see more errors. This time, the errors are in **WidgetView.swift** since the initializers of `SmallWidgetView`, `MediumWidgetView`, and `LargeWidgetView` in the `switch` case have not been passed the `category` argument. Pass the `category` argument to make the `body` of your `WidgetView` look similar to Listing 4-16.

Listing 4-16. The body of WidgetView after passing a category to all widget families

```
@ViewBuilder
    var body: some View {
        switch family {
        case .systemSmall: SmallWidgetView(eventCount: events.
        count, category: category)
        case .systemMedium: MediumWidgetView(events: events,
        category: category)
        case .systemLarge: LargeWidgetView(events: events,
        category: category)
        default: EmptyView()
        }
    }
```

In Listing 4-16, the `category` variable of `WidgetView` is passed as an argument for the `category` parameters of all families of widget views.

Now, the error remains only in **OnThisDayWidget.swift**. Add the `category` parameter and pass `entry.category` as its argument in `WidgetView`'s initializer to remove that error. After that, the body of `OnThisDayWidget` will look like Listing 4-17.

Listing 4-17. The body of OnThisDayWidget after passing a category to WidgetView's initializer

```
var body: some WidgetConfiguration {
    IntentConfiguration(kind: kind,
                        intent: EventCategoryIntent.self,
                        provider: IntentProvider()) { entry in
      WidgetView(events: entry.events, category: entry.category)
    }
    .supportedFamilies([.systemSmall, .systemMedium,
    .systemLarge])
    .configurationDisplayName("On This Day")
    .description("Events that occured this day.")
  }
```

If you have done everything mentioned earlier but are unable to understand what happened, let us explain. You passed the selected `category` received from the `entry` variable of the completion handler of the `IntentConfiguration` initializer in `OnThisDayWidget`, which is the entry point of your widget, to `WidgetView`, your main widget view. Then, from `WidgetView`, `category` was further passed to `SmallWidgetView`, `MediumWidgetView`, and `LargeWidgetView`.

Now, `SmallWidgetView`, `MediumWidgetView`, and `LargeWidgetView` are ready to use their `category` variables to display the selected category in the widgets. But before that, let's do some necessary setup.

Create a new folder **Intent** and move **EventCategory.intentdefinition** into that folder. Now, create a new Swift file in the **Intent** folder and name it **CategoriesExtension.swift**. Make sure that **OnThisDay** and **OnThisDayWidgetExtension** targets are selected while creating that file. Now, copy the code given in Listing 4-18 and paste it in **CategoriesExtension.swift**.

Listing 4-18. Creating an extension of Categories

```
extension Categories {
  var detail: String {
    switch self {
    case .births: return "births"
    case .all: return "historic events"
    case .events: return "events"
    case .deaths: return "deaths"
    case .holidays: return "holidays"
    case .selected: return "special events"
    default: return "historic events"
    }
  }
}
```

In Listing 4-18, an extension of `Categories` is created. It contains a `detail` variable of `String` type. Using the `switch` case, it returns the string to be displayed in the widgets according to the selected category.

Now, in `SmallWidgetView`, `MediumWidgetView`, and `LargeWidgetView`, search for the text `Text("events")` and replace it with `Text(category.detail)` so that the category of the selected event is displayed on the widget.

Finally, it's time to test your widgets!

Time to Put Your Widgets to the Test!

In your simulator or device, uninstall any existing installation of **OnThisDay** and remove any existing widget of **OnThisDay**. Then, select and run the **OnThisDay** target first to install it on your simulator or device. After that, select and run the **OnThisDayWidgetExtension** target to install the widgets. After the widgets are shown in the homescreen, try going to its configuration screen and selecting a different category. You can refer to Figures 4-10, 4-11, and 4-12. After selecting a new category, the information related to the events of that particular category should show up in your widget.

Well done! You have successfully made your widgets user configurable.

Navigating to the Relevant Screens of the App Through Tap Targets

Did you try tapping the different elements of your widgets you created in the previous section? The app must be launching and showing its homescreen no matter where you tap in your widgets. This should be changed as your widget is not your app icon, but way more than that. And it is also suggested in the Human Interface Guidelines to create such a widget, which when tapped should launch the app to show the screen containing the details and actions useful and relevant to the widget's content.

So, in this section, you will define tap targets that, when tapped, will use deep links to make navigation to various relevant screens of your app possible.

Note Deep linking is a technique with which you can make a link or URL not only open your app but also automatically navigate to the desired location of your app. It is very popular these days and has been adopted by various companies and organizations in their apps and services.

A nice example of a company utilizing the power of deep linking is Medium. If you open Medium's website and read an article in your phone's browser, you will see a button that says, "Open in app" at the top of the page. After tapping that button, if you are using an iOS device and do not have the Medium app installed, the App Store will launch in your device and display the installation page of the Medium app. But if you are using an iOS device with the Medium app installed, it will launch and take you to the same article you were reading, inside the app. That's some awesome deep linking magic!

For example, if you take a look at your medium-sized widget (Figure 4-18), you will see that there are various areas and elements which can be used as tap targets to make navigation to the screens containing the details and actions relevant to the tap targets' content possible. The potential tap targets are highlighted using rectangles with red borders in Figure 4-18.

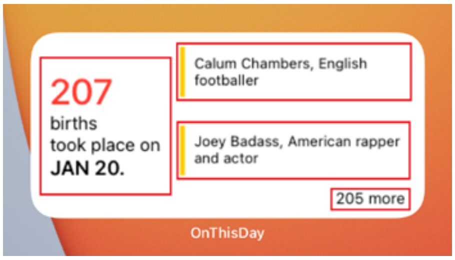

207
births
took place on
JAN 20.
Calum Chambers, English footballer
Joey Badass, American rapper and actor
205 more
OnThisDay

Figure 4-18. *Highlighting the elements which can be made tappable*

In Figure 4-18, the first potential tap target is the area that says, "207 births took place on JAN 20." As the currently selected category of events is **Births**, you can make that area tappable to navigate users to the app's homescreen that displays only the events lying in the **Births** category.

Also, you can see that there are a couple of birth events listed at the right side of the widget. So, you can define tap targets of each event in the list to directly navigate users to the detail screen of that tapped event. Hence, this time, the screen that will be displayed will not be the homescreen, but the detail screen with the content and actions relevant to the event that was tapped in the widget. For example, in Figure 4-18, if users tap the event that says, "Calum Chambers, English footballer," then users should see the detail screen containing the details about "Calum Chambers."

There is one more potential tap target that informs users that there are more events that could not be listed in the widget. In Figure 4-18, it says, “205 more.” Therefore, it’s obvious that by tapping it, users will expect to go to the app’s homescreen that displays all the events lying in the **Births** category.

Since the large-sized widget is similar to the medium-sized widget, the potential tap targets are the same.

But in the case of a small-sized widget, WidgetKit allows you to define only a single tap target, as it has little space and can accommodate less content. So, in your small widget, you can define a tap target that takes users to the homescreen that displays a list of events lying in the selected category.

Addition of Tap Target in Small Widget

In small widgets, you can add a tap target using the `widgetURL(_:)` method. It is an instance method of `View`, and it sets the URL to open in the app when users tap a widget. Another `View` method `onOpenURL(perform:)` detects if any deep link is trying to open the app, and that is where you perform necessary operations to make navigation to different screens possible. So, in the case of small widgets, these two methods play the key role to make navigation possible.

Now let’s set things up!

The `widgetURL(_:)` method takes a URL as an argument in order to set that URL for opening the app when its small widget is tapped. So, it is necessary to create a URL for the `widgetURL(_:)` method (which you will implement later). But what will you use to generate a URL? You will surely need a name or some other string for that. What about using the name of the selected category itself? That will be a nice way since you will get both the URL and the selected category value which you will use in the app’s homescreen to display the events lying in that category. Now, follow the given steps to develop a mechanism for generating a URL:

1. Open **CategoriesExtension.swift** from the **Intent** folder of **OnThisDayWidget**.
2. In the extension of `Categories`, copy the code of Listing 4-19 and paste it there to define a property, `eventType`, of type `EventType`.

Listing 4-19. Creating an eventType property in the Categories extension

```
var eventType: EventType {
    switch self {
    case .unknown, .all: return .all
    case .births: return .births
    case .deaths: return .deaths
    case .events: return .events
    case .holidays: return .holidays
    case .selected: return .selected
    }
  }
```

`eventType` was created in the `Categories` extension because you need to generate a `String` from the selected category of `Categories` type for creating a URL. Since `EventType` conforms to `String` and its `rawValue` property can be accessed to get the string of the selected category, you created `eventType` to map all the cases of `Categories` with `EventType` and get the string `rawValue`.

3. After that, open **SmallWidgetView.swift** in the **Views** folder of the **OnThisDayWidget** folder.

4. Replace the body of `SmallWidgetView` with the code given in Listing 4-20.

Listing 4-20. The body of SmallWidgetView after adding widgetURL(_:)

```
var body: some View {
      HStack {
            VStack(alignment: .leading) {
              Text(eventCount.description)
                .font(.system(size: 40,
                              weight: .medium))
                .foregroundColor(.red)
              Text(category.detail)
                .font(.body)
              Text("took place on")
                .font(.body)
              Text(DateHelper.today + ".")
                .font(.headline)
            }
            Spacer()
          }
      .padding([.leading, .top, .bottom])
      .widgetURL(URL(string: category.eventType.rawValue))
    }
```

In Listing 4-20, the `widgetURL(_:)` method is called by passing a URL created using the `rawValue` property of the `eventType` property of `category` as an argument.

5. Open **HomeView.swift** from the **Views** folder of **OnThisDay**. In HomeView, create a method, `handleLinks(for:)`, to handle deep linking and copy the code in Listing 4-21 and paste it there.

Listing 4-21. Implementation of handleLinks(for:)

```
func handleLinks(for url: URL) {
    if let type = EventType(rawValue: url.absoluteString) {
      self.type = type
    }
  }
```

In Listing 4-21, the `handleLinks(for:)` method is implemented. The `absoluteString`[3] property of `url` is accessed to get its string value, and the string value is passed to the `EventType` initializer that takes `rawValue` as an argument and tries to convert it to an `EventType` case. If a valid `EventType` case is generated, then it is stored in the `type` variable. At last, the `type` variable of `HomeView` is set to the value of the `type` variable of the `if-let` condition. Here, the `type` variable of `HomeView` is a `@State` variable that stores the selected event category/event type and displays the events accordingly.

6. Now, go to the body of `HomeView`. This is where you will call `onOpenURL(perform:)` to detect if a deep link is trying to launch your app.

[3] `https://developer.apple.com/documentation/foundation/nsurl/1409868-absolutestring`

Below the `onAppear(perform:)` function call in the body of `HomeView`, add the function call to `onOpenURL(perform:)` and make the changes shown in Listing 4-22.

Listing 4-22. HomeView's body after calling onOpenURL(perform:)

```
  var body: some View {
        NavigationView {
            // Some lines of code have been removed to make
               viewing easier
        }
// Some lines of code have been removed to make viewing easier
        .onAppear(perform: initiateDataFetch)
        .onOpenURL { url in
          handleLinks(for: url)
        }
    }
```

In Listing 4-22, the `onOpenURL(perform:)` method is called, whose completion handler gives a parameter, `url`. That parameter is passed to `handleLinks(for:)`, which performs the work of filtering the data and setting up the view to display events related to the selected event category/type.

Note The call to `onOpenURL(perform:)` is performed in the body of `HomeView` because `HomeView` is the main view that gets loaded from the entry point of the app, that is, `OnThisDayApp`. You will see it if you open the **OnThisDayApp.swift** file in the **OnThisDay** folder.

However, you could have called `onOpenURL(perform:)` from the `OnThisDayApp` struct using the instance of `HomeView`. But due to the availability of the data needed for performing necessary operations, you called it from the body of `HomeView`.

SwiftUI has given you the freedom to call `onOpenURL(perform:)` from any of these locations according to your preference and ease.

Now, build and run the project. Try changing the selected category of the events by long pressing the small widget, tapping **Edit Widget**, and modifying the value of the **Categories** field. Then, wait for the widget display information about the events of the selected category. After the fresh information is displayed in the widget, tap the widget to see the homescreen of the app displaying the list of events related to the selected category.

Well done! You have successfully added a tap target in your small widget and utilized the power of deep linking to make your app display relevant information.

Addition of Tap Target in Medium Widget

As shown in Figure 4-18, you can have multiple tap targets in your medium and large widgets. So, in this section, you will add tap targets in your medium widget.

In the medium widget, there are three regions where you can add tap targets. Open and preview `MediumWidgetView` so that it becomes easier for you to understand.

The first region/view is `eventCountView` that displays the number of events that took place on a particular date. It resembles your small widget.

The next region is the one where two events are listed. The `eventDetail(with:)` method is responsible to display that region. Each of them can have its own tap target that takes users to its detail screen.

And below that region, there is a `todayEvents` view that displays the number of remaining events that could not be accommodated in the widget view, but are displayed when the app is launched.

You must have noticed that the only region which will have a tap target that will perform a different function is the `eventDetail(with:)` method. Otherwise, no matter where you tap in the medium widget, users are supposed to be taken to the app's homescreen displaying a list of events related to the currently selected category. So, like in your small widget, you can call `widgetURL(_:)` from one of your views of your medium widget. Later, to add a tap target in the `eventDetail(with:)` method, you will use some other way than `widgetURL(_:)`.

Since you have already performed the setup necessary to handle deep links during the "Addition of Tap Target in Small Widget" (step 5 onwards), now you can simply call `widgetURL(_:)` from any view among `eventCountView` and `todayEvents` to make things work. Let's call `widgetURL(_:)` from `eventCountView`. Listing 4-23 shows the addition of the call to `widgetURL(_:)` in `eventCountView`.

Listing 4-23. Calling widgetURL(_:) from eventCountView

```
var eventCountView: some View {
  HStack {
    VStack(alignment: .leading) {
      Text(events.count.description)
        .font(.system(size: 40,
                      weight: .medium))
        .foregroundColor(.red)
      Text(category.detail)
        .font(.body)
      Text("took place on")
        .font(.body)
      Text(DateHelper.today + ".")
        .font(.headline)
    }
  }
  .padding(.trailing)
  .widgetURL(URL(string: category.eventType.rawValue))
}
```

In Listing 4-23, `widgetURL(_:)` was called in `eventCountView` by passing the URL created using the string generated by accessing the `rawValue` property of the `eventType` property of `category`, which is the selected category.

After adding the code in Listing 4-23, build and run the widget. Now, if you tap anywhere in the medium widget, you will get taken to the app's homescreen that lists the events related to the selected category.

However, if you remember, the region that displays brief information about two events at the right side of the widget is supposed to take users to their detail screens in the app to provide more relevant information. It's time to set it up.

In the case of the small widget, all you needed for the app to display the list of events of a selected category was the name of the selected category itself. And you created a URL using that category name and set it via `widgetURL(_:)`. When the widget was tapped, `onOpenURL(perform:)` would detect the deep link and the app would get launched and the homescreen with the list was displayed.

But you need a different mechanism to handle the case when an event is tapped in the medium (or large) widget, and the app should launch to open the detail screen of that particular event. Unlike in the small widget, here, you require both the event information (which will be used for the detail screen) and the selected category (which will be used to display the list of events of that particular category when users decide to go back to the app's homescreen).

As you will use deep linking for this case too, you will surely have to create a URL. So, why not generate a URL that will not only contain the selected category but also the text of the event? And to make the app sure about the screen it should navigate to when that particular deep link is detected, why not include some information about that screen too? It may not be very useful currently, but in scenarios where your app may have deep links for navigating to various screens, it can surely come handy.

So, let's create a mechanism that generates the URL containing the information about the selected category, the text of the event, and the name of the screen the app should navigate to:

1. In the **OnThisDayWidget** folder, create a new folder, **Constants**.
2. In **Constants**, create a new Swift file named **LinkConstants.swift**. While creating that file, make sure both **OnThisDay** and **OnThisDayWidgetExtension** targets are checked.
3. Copy the code in Listing 4-24 and paste it in **LinkConstants.swift**.

Listing 4-24. Creating a LinkConstants struct

```
struct LinkConstants {
  // a
  static let detailScheme = "detail"
  // b
  static func detail(with text: String, category: Categories)
  -> URL? {
    // c
    let queryItem = URLQueryItem(name: "text", value: text)
    // d
    var urlComponents = URLComponents()
    urlComponents.scheme = Self.detailScheme
    urlComponents.host = category.eventType.rawValue
    urlComponents.queryItems = [queryItem]
    // e
    if let url = urlComponents.url {
      return url
    }
    return nil
  }
}
```

In Listing 4-24, the `LinkConstants` struct is created, and the following things take place in it:

a. A static property, `detailScheme`, is defined, and its value is set to `"detail"`. You will use this property to let the app know that the deep link wants it to navigate to the detail screen of an event.

b. A static `detail(with:category:)` method is created. It is where your URL will be generated.

c. A `URLQueryItem` with its `name` parameter, `text`, and its `value` parameter set to the `text` received as an argument from `detail(with:category:)` is defined and stored in `queryItem`.

d. By creating an instance of `URLComponents` and storing it in `urlComponents`, the work of creating a URL is started here. The scheme is set to `detailScheme`, the host is set to the string form of `category`, and `queryItems` is set to an array containing the `queryItem` variable you created in step "a."

e. Using `if-let`, it is checked if a valid URL has been generated or not. If a valid URL is generated, it is stored in `url` and returned. Else, the method returns `nil`. A sample of the URL that is created is `detail://births?text=Cory%20Paix,%20Australian%20rugby%20league%20player`.

In this way, you have developed a mechanism to generate URLs using the selected category, the text of the event, and the destination screen's name.

Now, let's use the `detail(with:category:)` method you just created in `LinkConstants` and also set up the view of the medium widget for enabling navigation:

1. Open `MediumWidgetView` and replace `todayEvents` with the code given in Listing 4-25.

Listing 4-25. todayEvents with the Link view

```
var todayEvents: some View {
    VStack(spacing: 0) {
      ForEach(events.prefix(2)) { event in
        // a
        if let url = LinkConstants.detail(with: event.text,
        category: category) {
          Link(destination: url, label: {
            eventDetail(with: event)
          })
        } else {
          eventDetail(with: event)
        }
      }
      if events.count > 2 {
        HStack {
          Spacer()
          Text("\(events.count - 2) more")
            .font(.footnote)
            .padding(.trailing)
            .padding(.bottom, 8)
        }
      }
    }
  }
```

In Listing 4-25, a URL is generated by using the static `detail(with:category:)` method of `LinkConstants` and passing the text of the current iteration of `events`, that is, `event`, and the currently selected category, that is, `category`. If `detail(with:category:)` returns a valid URL, it is stored in `url`, and a `Link` view with its `destination` set to `url` and `label` set to the `eventDetail(with:)` method is created. Hence, the views that display brief information about events become tappable links to the URLs you generate. If `detail(with:category:)` does not generate a valid URL, just the view generated by the `eventDetail(with:)` method is displayed.

Tip You can check if the `Link` view is working or not by setting a breakpoint inside the `onOpenURL(perform:)` method in `HomeView`. Then, build and run the project and add the medium widget in your simulator or device's homescreen. After the updated information gets loaded in the widget, tap on any event and your app will launch, and the breakpoint will pause the execution inside `onOpenURL(perform:)`. Now check the deep link URL that passed by typing `po url` in Xcode's **Debug Console**. If the URL that is printed contains the data related to the event that you had tapped, it can be concluded that the `Link` view is working.

2. Open `HomeView` and define two `State` variables, `deepLinkEvent` of `EventData?` type and `deepLinkActive` of `Bool` type. Listing 4-26 shows the code that does it.

Listing 4-26. Defining deepLinkEvent and deepLinkActive

```
@State var deepLinkEvent: EventData?
@State var deepLinkActive: Bool = false
```

The `deepLinkEvent` variable defined in Listing 4-26 will be used later to store the data of the event that was tapped in the widget. Likewise, the `deepLinkActive` variable declared in Listing 4-26 will be used to activate/deactivate the `NavigationLink` responsible for navigation to an event's detail screen. You will add it later.

3. Let's create a method `handleLinkForDetail(with:)` in `HomeView` to handle operations related only to the navigation to an event's detail screen when a deep link is detected. Do it using the code given in Listing 4-27.

Listing 4-27. Creating handleLinkForDetail(with:)

```
func handleLinkForDetail(with url: URL) {
        // a
        guard let urlScheme = url.scheme,
              urlScheme == LinkConstants.detailScheme else {
              return }
        // b
        guard let urlType = url.host else { return }
        // c
        type = EventType(rawValue: urlType)!
        // d
        if let firstElement = url.queryParams.first {
            for eventType in otdViewModel.events {
                for event in eventType.value where event.text
                == firstElement.value {
                    deepLinkEvent = event
                    deepLinkActive = true
                }
            }
        }
    }
```

In Listing 4-27, the following things are happening:

a. `handleLinkForDetail(with:)` receives a URL as an argument and stores it in `url`. Using `guard-let`, it is checked if `url` contains a scheme or not. If a scheme is present, it is stored in `urlScheme`, and a check is performed if `urlScheme` matches with `LinkConstants.detailScheme` (whose value is `"detail"`) or not. This helps to verify if the deep link is meant to make the app navigate to a detail screen or not (we had talked about this in the step "a" of the explanation of Listing 4-24). Otherwise, the method will return and do nothing.

b. In this step, it is checked if `url` contains a host or not. If it contains a host, it is stored in `urlType`; otherwise, the method will return and do nothing. You have set up the URL in such a way that `urlType` will contain the string value of the selected event category.

c. Now, the value of `urlType` is passed to the `EventType` initializer to convert it into an `EventType` case. Since you can be sure that a `String` that can be converted into an `EventType` case has been passed, you can force-unwrap the result using the bang operator (`!`) and store it in `type` that stores the selected event category/event type and displays the events accordingly.

d. In this step, only the first query parameter passed in `url` is extracted using `if-let`, as you had passed only one query parameter containing the text of the event.

Now since `firstElement` contains the text of the event tapped, you can match it with the texts of the `events` variable of `otdViewModel` to find out the event data of that tapped event. These event data can then be used to initiate navigation to the detail page of the tapped event. The `events` variable is where the app stores all the events after fetching them using the API.

So, a `for` loop is run through the `events` variable of `otdViewModel`, setting the iteration variable to `eventType`. Again, another `for` loop is run through `eventType.value` to find out the text of the event that matches with the text of `firstElement`. As soon as an event is found, its value is stored in `deepLinkEvent`, which will make the value available throughout `HomeView`. And the `deepLinkActive` flag is set to `true` as it is verified that this is a valid deep link operation to navigate to the detail page.

4. Now it's time to call the `handleLinkForDetail(with:)` method you just created. Since the operations related to deep linking are mainly handled by the `handleLinks(for:)` method in `HomeView`, go there and replace it using the code in Listing 4-28 to give `handleLinks(for:)` some more responsibilities.

Listing 4-28. handleLinks(for:) with added responsibilities

```
func handleLinks(for url: URL) {
     deepLinkEvent = nil
     deepLinkActive = false
     if let type = EventType(rawValue: url.absoluteString) {
         self.type = type
     } else {
         handleLinkForDetail(with: url)
     }
 }
```

Listing 4-28 contains the updated version of the `handleLinks(for:)` method. No matter what `url` is received, initially, `deepLinkEvent` is set to `nil` and `deepLinkActive` is set to `false`. Then, if `url` contains a `String` that can be converted into an `EventType` case, it is stored in the `type` variable. After that, the value of the `type` variable is stored in the `type` variable of `HomeView`, which is responsible to set the selected event category/event type and display the event list accordingly in the homescreen. You had previously used this condition for the small widget and for some portion of the medium widget.

But if `url` does not contain such a `String`, then it is deduced that it is time to handle the deep link for navigating to the detail screen of an event. Hence, in the `else` condition, `handleLinkForDetail(with: url)` is called.

5. Now, the last thing remaining is to create a NavigationLink that gets activated and deactivated according to the deepLinkActive state variable of HomeView. When it gets activated, the app automatically navigates to the detail screen of an event. For that, create a variable named navigateToDetail by using the code given in Listing 4-29.

Listing 4-29. Defining the navigateToDetail variable

```
var navigateToDetail: some View {
        return self.deepLinkEvent.map({ event in
            NavigationLink(destination: DetailView(event:
            event), isActive: $deepLinkActive) {
                EmptyView()
            }.hidden()
        })
    }
```

In Listing 4-29, the navigateToDetail variable is created, whose function is to return some View. It first checks if a deepLinkEvent value is available or not by running map, and if the value exists, a NavigationLink with its destination set to DetailView, along with event data, and its isActive parameter set to $deepLinkActive, is created. Here, the "$" sign before deepLinkActive indicates that it is a binding. So, if there occurs any kind of change in deepLinkActive's value, then the whole body of HomeView automatically gets reloaded, and hence if deepLinkActive's value becomes true, the NavigationLink navigates to its destination, that is, DetailView. Also, the label of NavigationLink is an EmptyView() and the whole NavigationLink is hidden() as you do not want it to be visible anywhere on screen but just want it to work.

6. For a NavigationLink to work, it must be wrapped inside a NavigationView. So, the last step would be to somehow wrap navigateToDetail, which stores your NavigationLink, to the NavigationView in the body of HomeView. So, make navigateToDetail the background of the List wrapped by NavigationView in the body of HomeView. It is shown in Listing 4-30.

Listing 4-30. Setting navigateToDetail as the background of List in the body of HomeView

```
var body: some View {
    NavigationView {
        List {
            if type == .all {
                eventListWhenAllChecked
            } else {
                Group { eventView(for: type) }
            }
        }
        .background(navigateToDetail)
        .navigationTitle("On This Day")
        .navigationBarItems(leading: Text("\(today?.month ??
        "JANUARY") \(today?.day ?? 1)")
            .fontWeight(.semibold)
            .font(.body)
```

```
                .foregroundColor(.red),
                trailing: TrailingNavView(homeView: self))
        }
        .alert(isPresented: $isAlertDisplayed,
               content: {
                   Alert(title: Text("Oops!"),
                         message: Text("An error occured. Please
                         try reloading the data."),
                         dismissButton: .cancel(Text("OK")))
               })
        .onAppear(perform: initiateDataFetch)
        .onOpenURL { url in
          handleLinks(for: url)
        }
    }
```

If you see in Listing 4-30, exactly after the closing brace of `List`, `.background(navigateToDetail)` has been added to make `navigateToDetail` its background. In this way, you have successfully wrapped the `NavigationLink` stored by `navigateToDetail` in the `NavigationView` of `HomeView`'s `body`.

7. Finally, build and run the project and tap any event of the medium-sized widget to see the app launching and automatically navigating to the detail page of that particular event. If you tap the **Back** button, you will see the list of events related to the selected category only, in the homescreen of the app.

With this, you have completed adding a tap target in your medium widget. Now, the only widget where you have not set up tap targets is the large widget. You will do that in the upcoming section.

Addition of Tap Target in Large Widget

In the previous sections, you have already performed the setup necessary to create and handle deep links. That makes adding tap targets in your large widget easier. The only file you will modify now is `LargeWidgetView` to make tap targets in it work.

As `LargeWidgetView` is quite similar to `MediumWidgetView`, the first thing you can do is call the `widgetURL(_:)` method. This will create a tap target throughout the view that will make navigation to the app's homescreen that displays a list of events of the selected category. Replace the body of `LargeWidgetView` with the code given in Listing 4-31.

Listing 4-31. Calling widgetURL(_:) from LargeWidgetView's body

```
var body: some View {
        VStack(alignment: .leading, spacing: 0) {
            today
            Divider().padding(.vertical, 4)
            count
            todayEvents
            Spacer()
        }
        .padding(8)
        .widgetURL(URL(string: category.eventType.rawValue))
    }
```

Listing 4-31 modifies the body of `LargeWidgetView` by adding a call to `widgetURL(_:)`. The URL passed as an argument is created by using the `String rawValue` of the `eventType` property of `category`. Since you have set up everything to handle this deep link, if you build and run the project and you tap anywhere in the large widget, the app will launch and display a list of events of the selected category.

Now to add the feature to navigate to the detail screen of an event listed in the widget, you have to make modifications in `todayEvents`. Firstly, create a method `eventDetail(with:)` in `LargeWidgetView` by using the code given in Listing 4-32.

Listing 4-32. Creating eventDetail(with:)

```
func eventDetail(with event: WidgetEventData) -> some View {}
```

Listing 4-32 creates an `eventDetail(with:)` method that returns `some View`. Now, go to `todayEvents` and cut its `HStack` (everything inside the `ForEach` loop), and paste it in `eventDetail(with:)` to make it look like the code given in Listing 4-33.

Listing 4-33. Adding code to eventDetail(with:)

```
func eventDetail(with event: WidgetEventData) -> some View {
    HStack(spacing: 0) {
      Color.init(UIColor.systemYellow)
        .frame(width: 4)
        .padding(.vertical, 12)
      VStack {
        Text("\(event.text)")
          .font(.caption)
          .padding(.trailing, 8)
          .frame(maxWidth: .infinity, alignment: .leading)
      }.padding(8)
    }
  }
```

Listing 4-33 creates an `eventDetail(with:)` method that returns an `HStack`. If you look at the code of `todayEvents` now, you will see only the code shown in Listing 4-34.

Listing 4-34. The remnants of todayEvents

```
var todayEvents: some View {
        VStack(spacing: 0) {
            ForEach(events.prefix(3)) { event in
              // HStack was here
            }
            if events.count > 3 {
                HStack() {
                    Spacer()
                    Text("\(events.count - 3) more")
                        .font(.footnote)
                        .padding(.trailing)
                }
            }
        }
    }
```

The line where `HStack` existed previously has been marked with the comment, `// HStack was here`, in Listing 4-34. Now, replace the line that says `// HStack was here` with the code given in Listing 4-35.

Listing 4-35. The code that replaces the HStack

```
if let url = LinkConstants.detail(with: event.text, category:
category) {
                Link(destination: url) {
                  eventDetail(with: event)
                }
              } else {
                eventDetail(with: event)
              }
```

You had used the code in Listing 4-35 in `MediumWidgetView` too. The given code checks if a valid URL has been generated or not by passing `event.text` and `category` to the `LinkConstants.detail(with:category:)` method and by unwrapping the value returned by that method using an `if-let`. If a valid URL is generated, it is stored in `url`, and a `Link` with `destination` set to `url` wraps the call to `eventDetail(with:)` that is responsible to generate the `HStack` that displays the event details. Otherwise, only the `eventDetail(with:)` method is called.

Now, if you run the project and test your large widget, you will see that if you tap on any event, you get taken to its detail screen. And if you tap **Back** from a detail screen, the app displays the homescreen listing the events of the selected category.

In this way, you have successfully added tap targets in your large widget. Well done!

Summary

And you made it! In this chapter, you learned how you can make your widgets configurable and interactive to make your widgets more user-friendly. You used `IntentConfiguration` to make your widgets configurable, added tap targets in them, and used deep links to make navigation to the different screens of your app possible. In case of any confusion, do check out the final version of the code by opening the final project folder named **OnThisDayFinal** in **OnThisDay.zip**.

This chapter taught how you can provide hard-coded data to your widget's configuration. In the upcoming chapter, you will move a level ahead and provide dynamic data (fetched from an API) to your widget's configuration and make your widget even more powerful. Sounds exciting enough? Just keep going forward!

CHAPTER 5

Fetching Remote Configuration Options for Widgets

If you have made it to this chapter of the book, then till now you have gained an idea about how you can develop widgets of different sizes that not only display static data but also have the capability to fetch fresh data from a server at a specified interval. Also, you have learned how you can add tap targets to your widgets and also make your widgets configurable.

By following the procedure given in the previous chapter, you developed widgets that offered users a list of hard-coded configuration options, using which they configured their widgets. To be more specific, in the **OnThisDay** app's widgets, users could select a category of events from the widgets' configuration screen and, hence, make the widgets display event information related only to that particular category. You hard-coded all those categories which users could choose from. That is where the difference between that chapter and this chapter lies.

In this chapter, you will learn how you can fetch data from a server so that you can use those data as configuration options for the parameter in your configurable widgets. If you apply what you learned in this chapter to the **OnThisDay** app, you will be able to replace the category options you had previously hard-coded, with dynamic category options fetched from a server.

https://doi.org/10.1007/978-1-4842-7042-4_5

Now, we understand that you must have been fed up with working on the same app for a long time. So, in this chapter, you will work in a new app, **TwitterTrends** (our friends who love Twitter are gonna enjoy this).

Getting Started

To begin working on TwitterTrends, unzip the file named **TwitterTrends.zip**, and from the **TwitterTrendsStarter** folder, open **TwitterTrends.xcodeproj**. As this project needs to use Twitter's API endpoints, it is necessary to generate a bearer token. You have to pass that bearer token in the header of each request/API call, and Twitter checks that bearer token for authentication. If a valid bearer token is passed, Twitter sends a response with the data you request. Otherwise, Twitter will not give you access.

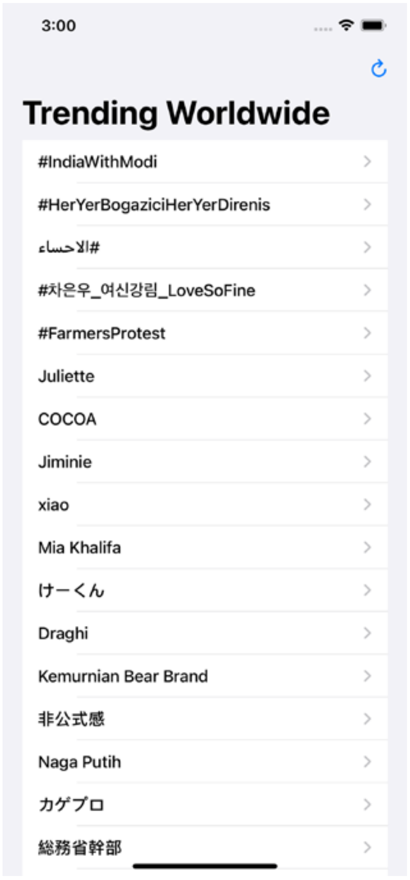
If you already own a Twitter Developer Account, you should be able to generate your own bearer token. But in case you do not own a developer account, you will first have to apply for it from Twitter's developer account page.[1] Generally, it takes a day or two, or sometimes even more, for Twitter to review your application.

If your Twitter Developer Account is ready to use, generate your own bearer token by going through the article at this link.[2] Then, open **TwitterTrendsAPI.swift** in the **TwitterTrends** folder of the project and replace the string that says, "Your bearer token here," with your bearer token string. Finally, you are ready to run the app.

Now, select the **TwitterTrends** scheme and run the project to see a screen similar to the screenshot shown in Figure 5-1.

[1]https://developer.twitter.com/en/apply-for-access

[2]https://developer.twitter.com/en/docs/authentication/oauth-2-0/bearer-tokens


3:00

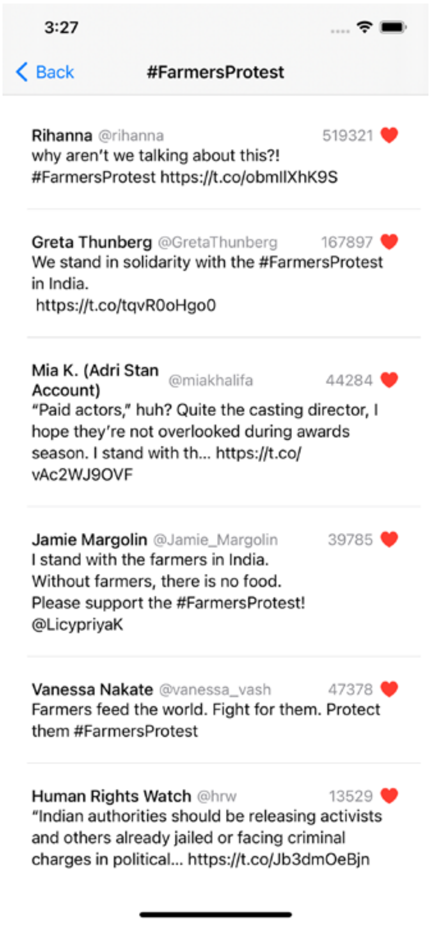
Trending Worldwide

#IndiaWithModi
#HerYerBogaziciHerYerDirenis
#الاحساء
#차은우_여신강림_LoveSoFine
#FarmersProtest
Juliette
COCOA
Jiminie
xiao
Mia Khalifa
けーくん
Draghi
Kemurnian Bear Brand
非公式感
Naga Putih
カゲプロ
総務省幹部

Figure 5-1. *The homescreen of TwitterTrends displaying a list of trends trending worldwide on Twitter*

Figure 5-1 shows the TwitterTrends app's homescreen displaying a list of top trends trending worldwide on Twitter. TwitterTrends does this by making use of Twitter's **GET trends/place**[3] API endpoint. If you play with the app, you will see that you can tap each trend to get taken to a screen that displays tweets related to that trend (Figure 5-2).

[3]https://developer.twitter.com/en/docs/twitter-api/v1/trends/trends-for-location/api-reference/get-trends-place



Rihanna @rihanna 519321
why aren't we talking about this?! #FarmersProtest https://t.co/obmIlXhK9S

Greta Thunberg @GretaThunberg 167897
We stand in solidarity with the #FarmersProtest in India.
https://t.co/tqvR0oHgo0

Mia K. (Adri Stan Account) @miakhalifa 44284
"Paid actors," huh? Quite the casting director, I hope they're not overlooked during awards season. I stand with th... https://t.co/vAc2WJ9OVF

Jamie Margolin @Jamie_Margolin 39785
I stand with the farmers in India.
Without farmers, there is no food.
Please support the #FarmersProtest!
@LicypriyaK

Vanessa Nakate @vanessa_vash 47378
Farmers feed the world. Fight for them. Protect them #FarmersProtest

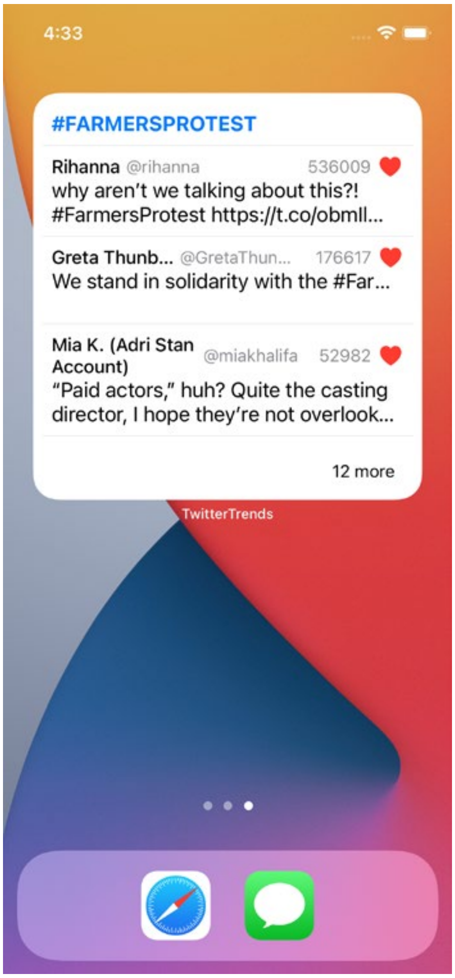
Human Rights Watch @hrw 13529
"Indian authorities should be releasing activists and others already jailed or facing criminal charges in political... https://t.co/Jb3dmOeBjn

Figure 5-2. *TwitterTrends displaying a list of tweets about the trend "#FarmersProtest"*

Figure 5-2 shows the screen with a list of tweets which was shown after the #**FarmersProtest** trend was tapped in TwitterTrends' homescreen. The list of tweets has been fetched by using Twitter's **GET search/tweets**[4] API endpoint.

[4]https://developer.twitter.com/en/docs/twitter-api/v1/tweets/search/api-reference/get-search-tweets

To sum up, TwitterTrends lets users know about the top Twitter trends and also fetches the tweets related to those trends. But wait, did you check out the widget of TwitterTrends? TwitterTrends has a large widget (Figure 5-3) that displays the tweets related to the first trend of the array returned as a response by Twitter's **GET trends/place** API endpoint.



#FARMERSPROTEST

Rihanna @rihanna 536009
why aren't we talking about this?! #FarmersProtest https://t.co/obmll...

Greta Thunb... @GretaThun... 176617
We stand in solidarity with the #Far...

Mia K. (Adri Stan Account) @miakhalifa 52982
"Paid actors," huh? Quite the casting director, I hope they're not overlook...

Figure 5-3. *Large-sized widget of TwitterTrends*

In Figure 5-3, you can see how the large widget of TwitterTrends looks. The large widget is the only widget family that TwitterTrends has. At the top of the widget, the name of the trend is displayed. Below that, the tweets related to that trend are listed, along with some more information about each tweet. If there are more than three tweets, a `Text` that displays the number of tweets that could not be accommodated in the widget is shown.

Right now, if you try to edit the widget and configure it, you will see that there exists no option to do that. But in the upcoming sections, you will make your app configurable (Figure 5-4). Users will be able to choose a trend from a list of trends fetched from Twitter's API endpoint (and not a list of hard-coded trends), and the widget will then display tweets related to that trend. This is what makes this chapter different from the previous one – fetching configuration options from a server and not hard-coding them.

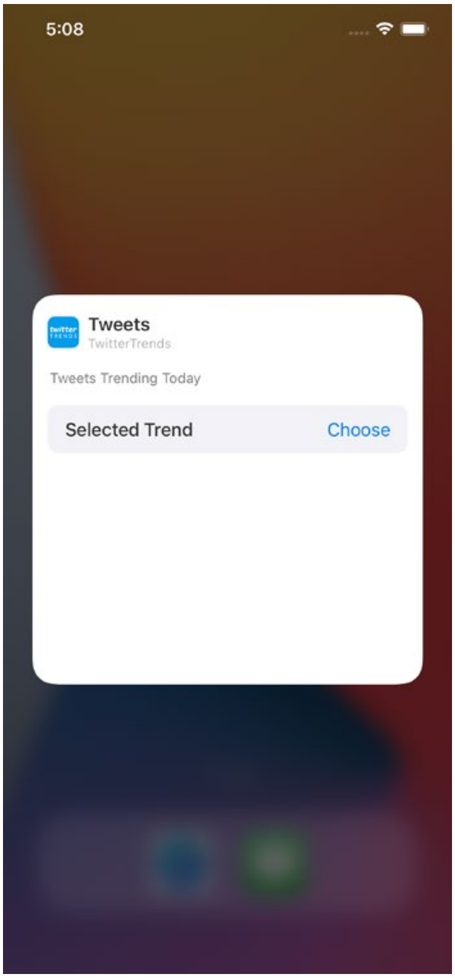
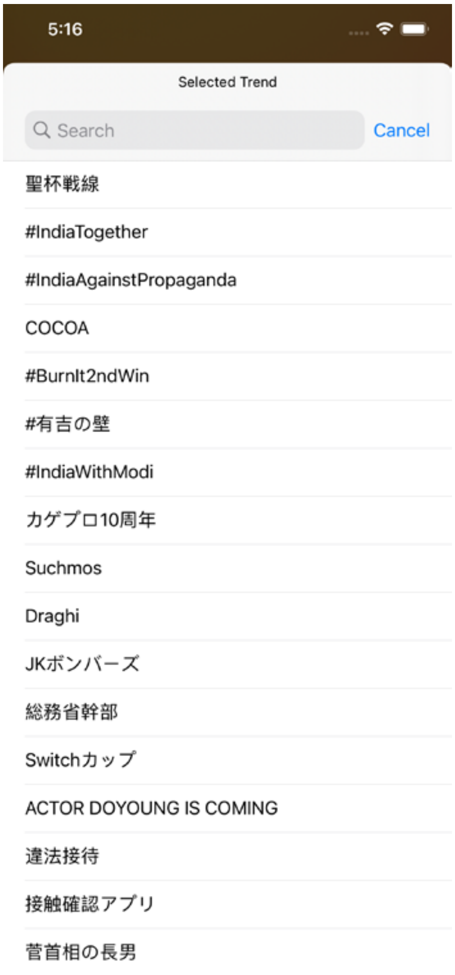


Figure 5-4. *The configuration screen of TwitterTrends' widget*

Figure 5-4 displays the configuration screen of TwitterTrends' widget that you will develop in the upcoming sections. The configuration screen consists of a parameter, **Selected Trend**, which is currently asking users to **Choose** a trend since no trend has been selected yet. After tapping **Choose**, users will see a screen that lists the Twitter trends trending worldwide (Figure 5-5). Those trends will be fetched from Twitter's **GET trends/place** API endpoint.



Selected Trend

聖杯戦線
#IndiaTogether
#IndiaAgainstPropaganda
COCOA
#BurnIt2ndWin
#有吉の壁
#IndiaWithModi
カゲプロ10周年
Suchmos
Draghi
JKボンバーズ
総務省幹部
Switchカップ
ACTOR DOYOUNG IS COMING
違法接待
接触確認アプリ
菅首相の長男

Figure 5-5. *The trends users can choose from to set as the "Selected Trend"*

From the screen shown in Figure 5-5, users can choose any one of the trends, and then the widget will display tweets related to that selected trend.

Doesn't that sound fun? Now let's take a look at the already existing code. We have already set up some basic stuff for you in TwitterTrends.

If you go to the **Project Navigator** and open the **TwitterTrends** project, you will see two main folders, that is, **TwitterTrends** and **TwitterTrendsWidget**. The **TwitterTrends** folder contains the files and folders related to the app, and the **TwitterTrendsWidget** folder contains the files and folders related to the widget. And there are certain files which are shared by both folders using **Target Membership**.

If you open the **TwitterTrends** folder in the **TwitterTrends** project, you will see the following folder structure:

```
TwitterTrends
├── Assets.xcassets
├── Extensions
│   └── View.swift
├── Info.plist
├── Models
│   ├── TrendTweets.swift
│   ├── Trends.swift
│   └── Tweets.swift
├── Preview\ Content
├── TwitterTrendsAPI.swift
├── TwitterTrendsApp.swift
├── ViewModel
│   └── TTViewModel.swift
└── Views
    ├── TrendsView.swift
    └── TweetsView.swift
```

In the **TwitterTrends** folder, other than **Assets.xcassets** and **Info.plist**, you will see the **Extensions** folder that contains a file named **View.swift**. It contains an extension of `View` that helps to handle the `redacted(reason:)` view modifier.

The **Models** folder contains **TrendTweets.swift**, **Trends.swift**, and **Tweets.swift**, which are the models used for decoding the response data received from Twitter's API. These files are used by both the app and the widget.

The **Preview Content** folder is a folder generated automatically by Xcode for storing the assets required for development purposes. Xcode does not include any assets in this folder in your release builds.

The next file is **TwitterTrendsAPI.swift**. It is responsible to handle communications with Twitter's API endpoints. This file is used by both the app and the widget to fetch tweets and trends from Twitter.

There is a file named **TwitterTrendsApp.swift** which is the entry point of the app.

Now, the only folders remaining are **ViewModel** and **Views**. The **ViewModel** folder consists of **TTViewModel.swift**, which contains the view model used by the app. And **Views** contains **TrendsView.swift** and **TweetsView.swift** which contain the user interface of the screens that display the top trends and the tweets related to those trends, respectively.

That's the description of the folders and files in the **TwitterTrends** folder.

There is another folder called **TwitterTrendsWidget** in the project. If you open it, you will see the folder structure given as follows:

```
TwitterTrendsWidget
├── Assets.xcassets
├── Info.plist
├── Model
│    └── TweetWidgetEntry.swift
├── Provider
│    └── TwitterProvider.swift
├── View
│    └── LargeWidgetView.swift
└── Widget
     └── TwitterTrendsWidget.swift
```

Currently, there are less files and folders in **TwitterTrendsWidget**. In addition to **Assets.xcassets** and **Info.plist**, there is a folder called **Model** that contains **TweetWidgetEntry.swift**. This file contains a `TimelineEntry` called `TweetWidgetEntry` which is vital for your widgets to work.

The **Provider** folder contains **TwitterProvider.swift**, which is the `TimelineProvider` of the widget.

Likewise, you can see another folder, **View**. It contains **LargeWidgetView.swift**, which contains the user interface of your widget.

Lastly, there is a folder called **Widget**, and it contains **TwitterTrendsWidget.swift**. It is the entry point of your widget.

Throughout this chapter, you will add more files and folders in your widget's folder and give your widget the power to fetch configuration options from a remote server.

Now, it's finally time to start working to give your widget the capability to communicate with Twitter's API to fetch the top trends and allow users to select any one of them to see the tweets related to that particular trend in the widget.

Time to Create a SiriKit Intent Definition File

This step is similar to that of the previous chapter. In this step, you will create an intent definition file, and using that file you will define configurable properties for your widgets. To create that file, follow the steps mentioned as follows:

1. Right-click the **TwitterTrendsWidget** folder in the project and click **New Group** to create a new folder. Name it **Intent**.

2. Now, right-click the **Intent** folder and click **New File...**.

3. In the dialog box that appears, select **SiriKit Intent Definition File**, name it **TwitterTrends.intentdefinition**, and create the file. While creating the file, make sure that both **TwitterTrendsWidgetExtension** and **TwitterTrends** targets are checked at the bottom of the dialog box.

4. Open **TwitterTrends.intentdefinition** and click the "+" icon at the bottom left of the intent file. After that, from the list of options, click **New Intent** (Figure 5-6).

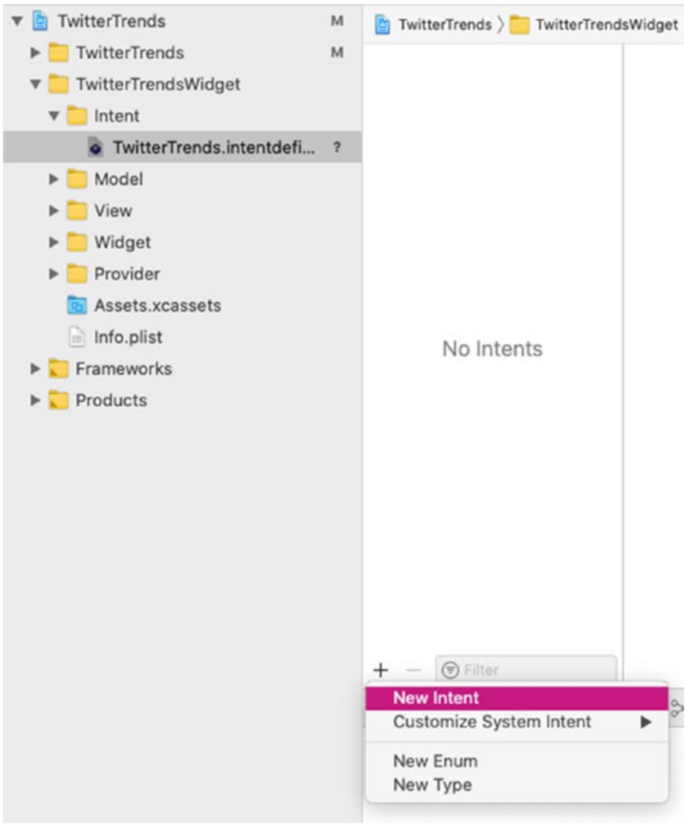


Figure 5-6. *Creating a new intent in the intent definition file*

5. Name the intent as **Trends** and modify some configuration of that intent. Since you are going to use the intent for widgets only, put a checkmark on **Intent is eligible for widgets** and remove checkmarks from **Intent is user-configurable in the Shortcuts app and Add to Siri** and **Intent is eligible for Siri Suggestions**.

6. Now, add a parameter named **selectedTrend** in the **Parameters** section by clicking the "+" button below it. Parameters are the properties that users will see and modify in the configuration screen of your widget to configure your widget. The display name that is displayed in the configuration screen of your widget (Figure 5-4) is automatically set to **Selected Trend**.

7. Then, change the type of the **selectedTrend** parameter to **Add Type...** (Figure 5-7).

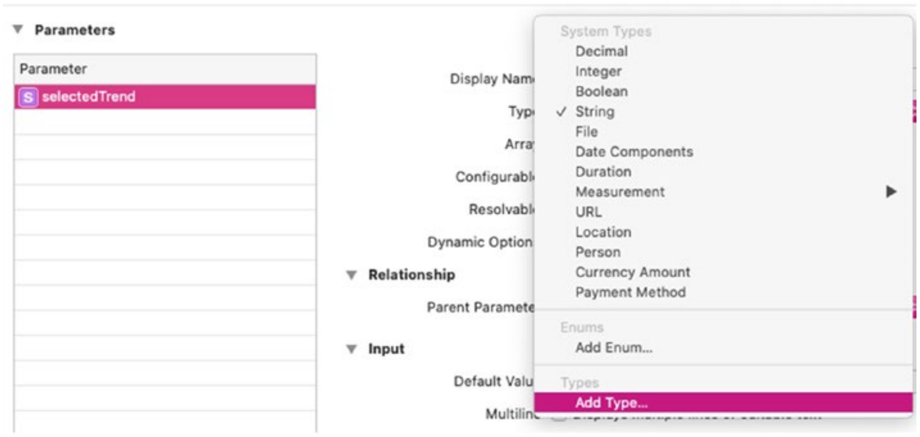


***Figure 5-7.** Creating a parameter called "selectedTrend" and changing its "Type" to "Add Type..."*

8. As soon as you click **Add Type...**, a new screen is displayed that appears similar to Figure 5-8. Change the name of the new type to **SelectedTrend** by typing it in the item under the **TYPES** header at the left.

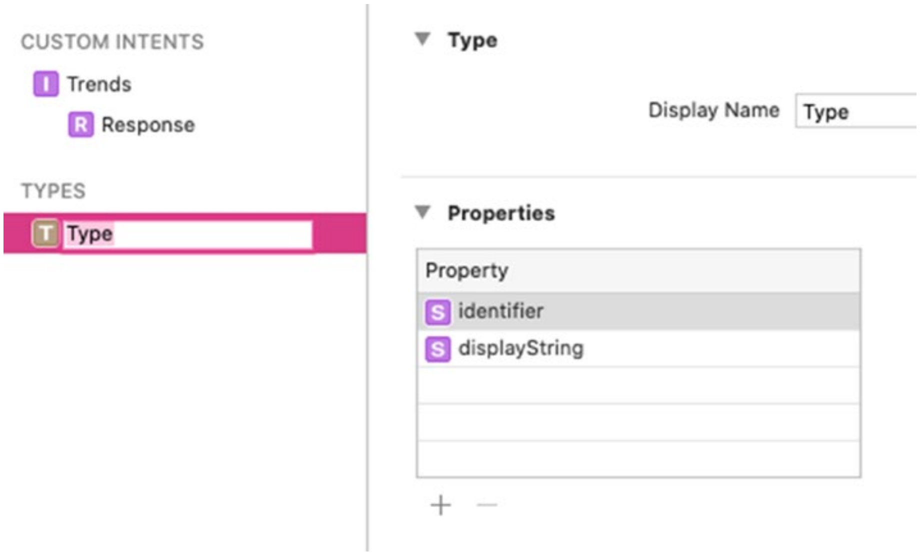


Figure 5-8. *The screen shown after clicking "Add Type."*

9. Again, go back to the **Trends** custom intent and select the **selectedTrend** parameter and add a checkmark in **Options are provided dynamically** as you want to provide options for that parameter dynamically by fetching them from a remote server. Also, remove the checkmark from **Siri can ask for value when run** since you do not want to work with Siri.

In this way, you have created an intent definition file and added the parameter, **selectedTrend**, using which users will select a trend of their choice from the widget's configuration screen.

Setting Up IntentHandler to Fetch Top Trends and Send Them to the Widget

Now, you have to add a mechanism to use **selectedTrend** parameter when the timeline is created. In the previous chapter, it was a straightforward and simple process, as you had an `enum` with a set of values you had defined or hard-coded. But this time, you are using a `class`, and things are going to be different.

So, first, you need to provide the widget the values that the **selectedTrend** parameter of **SelectedTrend** type can hold. For that, you will require an intent handler that will be responsible to fetch those values from the server and provide them to your widget.

1. In Xcode, go to **File ➤ New ➤ Target** to create a new target. In the dialog box that appears, select **Intents Extension** and click **Next**.

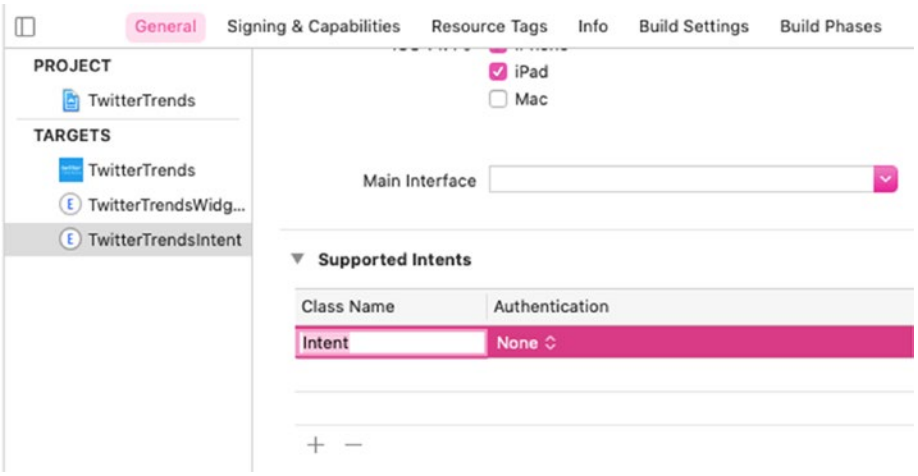
2. In the dialog box displayed, set **TwitterTrendsIntent** as **Product Name**, **Swift** as **Language**, and **None** as **Starting Point**. Make sure that **Include UI Extension** is not checked. And set **Project** to **TwitterTrends** and the value of **Embed in Application** to **TwitterTrends**. Then, click **Finish**. And click **Cancel** if you are asked to **Activate "TwitterTrendsIntent" scheme** because you will not have to activate that scheme to run your widget or app later.

   Now, a new folder called **TwitterTrendsIntent** is created in your project, and it contains **IntentHandler.swift** and **Info.plist**. The **IntentHandler.swift** file is where you will write the code to fetch the top trends from Twitter's server and send them to your widget.

3. Now, open the **TwitterTrends.intentdefinition** file in **TwitterTrendsWidget**'s **Intent** folder and update its **Target Membership** by adding a checkmark to **TwitterTrendsIntent**. Now, that file is accessible from **TwitterTrends**, **TwitterTrendsWidget**, and **TwitterTrendsIntent**.

4. One thing to keep in mind is that the **TwitterTrendsIntent** target should know the types of intents it can support. For that, select the **TwitterTrends** project (and not the TwitterTrends folder) located at the top of the **Project Navigator** to go to project settings. Now, select the **TwitterTrendsIntent** target under the **TARGETS** section and go to its **General** tab.

5. In the **General** tab of **TwitterTrendsIntent**, go to the **Supported Intents** section and click the "+" sign below it to add a new supported intent. Then the screen will look like Figure 5-9.



Class Name	Authentication
Intent	None

Figure 5-9. *The screen shown after clicking the "+" icon below Supported Intents*

6. Type **TrendsIntent** under the **Class Name** heading. Since you have made **TwitterTrends.intentdefinition** a member of the **TwitterTrendsIntent** target in step 3, you will see a suggestion as soon as you begin typing. The name **TrendsIntent** has been generated automatically by Xcode using the name of the custom intent, **Trends**, you had added in **TwitterTrends.intentdefinition** in step 5 of the **Time to Create a SiriKit Intent Definition File** section of this chapter. At last, let **TrendsIntent**'s **Authentication** remain **None**.

7. Now, open **IntentHandler.swift** in the **TwitterTrendsIntent** folder. Right now, the **IntentHandler** class is inheriting from the **INExtension** class. Now make **IntentHandler** conform to the **TrendsIntentHandling** protocol that has been generated automatically by Xcode. After doing that, your code in **IntentHandler.swift** will look like Listing 5-1.

Listing 5-1. IntentHandler after conforming to TrendsIntentHandling

```
import Intents

class IntentHandler: INExtension, TrendsIntentHandling {

    override func handler(for intent: INIntent) -> Any {
        return self
    }

}
```

8. As soon as you make `IntentHandler` conform to `TrendsIntentHandling`, Xcode will show you an error message saying, "Type 'IntentHandler' does not conform to protocol 'TrendsIntentHandling'. Do you want to add protocol stubs?" It is because you have not yet implemented the properties of the `TrendsIntentHandling` protocol in `IntentHandler`.

9. Click **Fix** to see Xcode generate the implementation of `provideSelectedTrendOptionsCollection(for:with:)`. This is where you will fetch top Twitter trends by communicating with its servers using `TwitterTrendsAPI`. But `TwitterTrendsAPI` is not currently accessible from **IntentHandler.swift**. So, you need to update its **Target Membership**.

10. Open **TwitterTrendsAPI.swift** in the **TwitterTrends** folder. Then, update its **Target Membership** by adding a checkmark to **TwitterTrendsIntent**. Now you will be able to access it from **IntentHandler.swift**.

11. Open **IntentHandler.swift** and implement `provideSelectedTrendOptionsCollection(for:with:)` by replacing the current implementation with the code given in Listing 5-2.

Listing 5-2. Implementation of provideSelectedTrendOptionsCollection(for:with:)

```
func provideSelectedTrendOptionsCollection(for intent:
TrendsIntent, with completion: @escaping (INObjectCollection
<SelectedTrend>?, Error?) -> Void) {
        // a
        TwitterTrendsAPI.getAvailableTrends { response in
            // b
            switch response {
            // c
            case .success(let trends):
                // d
                if let firstTrend = trends.first {
                    // e
                    let availableTrends = firstTrend.trends
                    // f
                    let usableTrends: [SelectedTrend] =
                    availableTrends.map { element in
                        return SelectedTrend(identifier:
                        element.query, display: element.name)
                    }
                    // g
                    let inObjectCollection: INObjectCollection
                    = INObjectCollection(items: usableTrends)
                    completion(inObjectCollection, nil)
                }
            case .failure(let error):
                // h
                print(error.localizedDescription)
            }
        }
    }
```

After pasting the code of Listing 5-2, you must be seeing a lot of errors. So, before describing what is happening in Listing 5-2, first let's get rid of the errors. If you go through the error messages, you will see that Xcode is complaining about being unable to find the types `Trends`, `TrendTweets`, `Trend`, and `Tweets`. It is because `TwitterTrendsAPI` is now a member of the **TwitterTrendsIntent** target also, but the `structs` that it uses (`TrendTweets`, `Trend`, and `Tweets`) are not the members of that target. So, you need to make those `structs` members of **TwitterTrendsIntent**.

From the **Models** folder of **TwitterTrends**, open **TrendTweets.swift** and update its **Target Membership** by putting a checkmark on **TwitterTrendsIntent**. Repeat the same for **Trends.swift** and **Tweets.swift** too.

12. Now build your project to find all the errors gone. Now, let's get back to knowing what is happening in Listing 5-2.

    a. Since the `provideSelectedTrendOptionsCollection(for:with:)` method is the location from where you will fetch top Twitter trends and pass them as the options of the **selectedTrend** parameter, you begin the implementation by calling the `getAvailableTrends(id:completion:)` method of `TwitterTrendsAPI`.

    b. `getAvailableTrends(id:completion:)` returns `response` using its completion handler. `response` can either be `.success` or `.failure`. So, it is put through a `switch` case.

    c. If `response` has a `.success` value, it contains `trends` which is the data about the top trends.

    d. If you study the response format of Twitter's **GET trends/place** API endpoint, you will see that it returns an array with a single object. That single object is accessed using `trends.first` and stored in `firstTrend`.

e. Now, all the trends that have been fetched are stored in the `trends` property of `firstTrend`. So, they are accessed using `firstTrend.trends` and stored in `availableTrends`.

f. Since you have defined the data type of the **selectedTrend** parameter in **TwitterTrends.intentdefinition** as **SelectedTrend**, now you will have to convert the trends fetched from Twitter's API to that type. For that, `map` is run through all the values in the `availableTrends` array, and each iteration's `query` and `name` are used to create a new `SelectedTrend` instance. Then, they are stored in the `usableTrends` array, which is an array that stores `SelectedTrend` values.

g. In this step, `usableTrends` is passed into the `INObjectCollection` initializer and stored in `inObjectCollection`. Then, the completion handler is called by passing `inObjectCollection` as an argument. This is how the top trends fetched from Twitter's server are sent to the **selectedTrend** parameter of the widget.

h. In case `response` contains `.failure`, then its `error` property is accessed and printed into the console.

   In this way, you fetched the trends from Twitter's API, converted them to the type of the **selectedTrend** parameter you created in **TwitterTrends.intentdefinition**, and passed them to **selectedTrend**.

Switching to IntentConfiguration

Right now, if you build and run your project, you will see that long pressing your widgets does not give the option to **Edit Widget**. It is because you have still not made necessary preparations to replace `StaticConfiguration` with `IntentConfiguration`. And to use `IntentConfiguration`, you will need a different timeline provider than the one you are using right now. Just follow the steps given to make "the big switch" to `IntentConfiguration`.

Create an IntentTimelineProvider

As mentioned previously, the first step to switch to `IntentConfiguration` is to set up an `IntentTimelineProvider`. Go through the given steps to set it up:

1. Right-click the **Provider** folder of the **TwitterTrendsWidget** folder, click **New File...**, and create a new Swift file named **TwitterTrendsIntentProvider.swift**. Make sure the **TwitterTrendsWidgetExtension** target is checked at the bottom of the dialog box before creating the file.

Note You could use the existing **TwitterProvider.swift** file instead of creating **TwitterTrendsIntentProvider.swift**, but for better clarity, we recommend you to create **TwitterTrendsIntentProvider.swift**.

---

2. Open **TwitterTrendsIntentProvider.swift** and replace the existing code content with the code given in Listing 5-3.

Listing 5-3. Creating TwitterTrendsIntentProvider that conforms to IntentTimelineProvider

```
import SwiftUI
import WidgetKit

struct TwitterTrendsIntentProvider: IntentTimelineProvider {

}
```

3. In Listing 5-3, a struct named `TwitterTrendsIntentProvider` that conforms to `IntentTimelineProvider` is created. As soon as you add the code, Xcode will ask if you want to add protocol stubs. Click **Fix** and add them to see two typealiases, `Entry` and `Intent`, added to the struct.

4. In `TwitterTrendsIntentProvider`, replace the `type` placeholder of `Entry` with `TweetWidgetEntry`, a type of timeline entry. Also, replace the `type` placeholder of `Intent` with `TrendsIntent`, whose name was generated from the custom intent, `Trends`, you had created in **TwitterTrends.intentdefinition**.

Now your code should look like the code in Listing 5-4.

Listing 5-4. TwitterTrendsIntentProvider after adding Entry and Intent types

```
import SwiftUI
import WidgetKit

struct TwitterTrendsIntentProvider: IntentTimelineProvider {
    typealias Entry = TweetWidgetEntry
    typealias Intent = TrendsIntent
}
```

5. You will still see Xcode asking you to add protocol stubs. Add them too. Then, `placeholder(in:)`, `getSnapshot(for:in:completion:)`, and `getTimeline(for:in:completion:)` methods will get generated.

6. For implementing the `placeholder(in:)` and `getSnapshot(for:in:completion:)` methods of `TwitterTrendsIntentProvider`, you can copy the code from the `placeholder(in:)` and `getSnapshot(for:in:completion:)` methods of `TwitterProvider` in **TwitterProvider.swift** as the same implementations will work.

7. The `getTimeline(for:in:completion:)` method of `TwitterTrendsIntentProvider` is different than the `getTimeline(in:completion:)` method of `TwitterProvider` as `TwitterTrendsIntentProvider` conforms to `IntentTimelineProvider`, but `TwitterProvider` conforms to `TimelineProvider`. And the `getTimeline(for:in:completion:)` method of `TwitterTrendsIntentProvider` allows you to access the data from the configuration of the widget.

   In the current scenario, you will access the selected trend from the widget's configuration and use it to perform the API call to fetch tweets related to that selected trend. In case there isn't a selected trend, you will make the widget fetch the tweets related to the first trend in the array of the trends fetched from Twitter's API. And you will do everything in `getTimeline(for:in:completion:)`.

Before you start working on `getTimeline(for:in:completion:)`, let's first create a method, `createTimelineFromTweets(response:)`, to create a timeline from the tweets that will be fetched from the API. Then, you can call this method from `getTimeline(for:in:completion:)`. This will make the code readable and easy to understand. Copy the code given in Listing 5-5 and paste it in `TwitterTrendsIntentProvider`.

Listing 5-5. Creating the createTimelineFromTweets(response:) method

```
func createTimelineFromTweets(response: Result<TrendTweets,
Error>) -> Timeline<TweetWidgetEntry> {
        // a
        let currentDate = Date()
        // b
        let refreshDate = Calendar.current.date(byAdding:
        .minute, value: 30, to: currentDate)!
        // c
        var entry = TweetWidgetEntry(date: refreshDate,
        statuses: Tweets.dummyTweets, trendTitle: "")
        // d
        var timeline = Timeline(entries: [entry], policy:
        .after(refreshDate))

        // e
        switch response {
        case let .success(tweets):
            // f
            entry = TweetWidgetEntry(date: refreshDate,
            statuses: tweets.statuses, trendTitle: tweets.title)
            timeline = Timeline(entries: [entry], policy:
            .after(refreshDate))
            return timeline
        case let .failure(error):
            // g
            print(error.localizedDescription)
            return timeline
        }
    }
```

In Listing 5-5, you created a method `createTimelineFromTweets(response:)` that has `response` as the parameter and returns a timeline. In it, the following things have been done:

a. At the beginning, the current date is stored in `currentDate`.

b. Now, the date after adding 30 minutes to `currentDate` is generated and stored in `refreshDate`. You will use it later to set up the widget's refresh policy.

c. In this step, the `TweetWidgetEntry` timeline entry is created by passing `refreshDate`, dummy tweets, and an empty title string to its initializer. Then, it is stored in `entry`.

d. Now a timeline is created using `entry` and by setting the refresh policy to make the widget request a new timeline after 30 minutes. In this way, the timeline is created.

e. As `response` may either have a `.success` value or a `.failure` value, it is put through a `switch` case. If `response` has a `.success` value, it uses tweets received with .success and creates a new TweetWidgetEntry by using tweets' title and statuses properties. Then, the value of the entry variable is replaced by this new entry. And the value of the timeline variable is also replaced with a new timeline created using the new value of entry, and therefore the timeline is returned.

f. In case response contains .failure, the error variable is accessed, and its value is printed into the console. Also, since the method must return a timeline, the timeline variable with dummy tweets and empty title (that you created in steps "c" and "d") is returned.

8. Now it's time to start working in the getTimeline(for:in:completion:) method. Replace the existing getTimeline(for:in:completion:) method with the code given in Listing 5-6.

Listing 5-6. Implementation of the getTimeline(for:in:completion:) method

```
func getTimeline(for configuration: TrendsIntent, in context:
Context, completion: @escaping (Timeline<TweetWidgetEntry>) ->
Void) {
        // a
        if let trend = configuration.selectedTrend {
            let selectedTrend = Trend(name: trend.
            displayString, query: trend.identifier!)
            TwitterTrendsAPI.getTweets(on: selectedTrend) {
            response in
```

```
                completion(createTimelineFromTweets(response:
                response))
            }
        } else { // b
            TwitterTrendsAPI.getLatestTweets { response in
                completion(createTimelineFromTweets(response:
                response))
            }
        }
    }
```

In Listing 5-6, the implementation of the `getTime line(for:in:completion)` method is given. The following things take place in Listing 5-6:

a. This method checks for two cases – the first is the case when there exists a value of `selectedTrend` in `configuration`, and the second one is the case when `selectedTrend` does not contain any value. The `selectedTrend` property is the parameter that you had created in **TwitterTrends.intentdefinition** in the previous sections of this chapter.

   In the current step, the code checks if users have already selected a trend from their configuration screen. Thus, if users have selected a trend, meaning that there exists a value in `selectedTrend`, it is stored in `trend`, and a new instance of `Trend` is created by using the trend's `displayString` and `identifier`.

   Then, the `getTweets(on:completion:)` method of `TwitterTrendsAPI` is called to fetch the tweets related to that trend. When a `response` is received, the completion handler of the `getTimeline(for:in:completion:)` method is called by passing the call to `createTimelineFromTweets(response:)` as its argument.

The `createTimelineFromTweets(response:)` takes the `response` received from the API call as an argument, generates a timeline, and returns it. At last, the completion handler of `getTimeline(for:in:completion:)` uses that timeline, and a timeline is created for the widget.

b. But in case users have not selected any trend (or there is no value in the `selectedTrend` property of `configuration`), the `getLatestTweets(completion:)` method of `TwitterTrendsAPI` is called. This method first fetches all the trends from Twitter's API, selects the first trend from the API's response, fetches the tweets related to that trend, and returns it as `response`. On receiving the response, the completion handler of the `getTimeline(for:in:completion:)` method is called by passing the call to `createTimelineFromTweets(response:)` as its argument.

   Then, the `createTimelineFromTweets(response:)` uses the `response` received from the API call as an argument, generates a timeline, and returns it. At last, the completion handler of `getTimeline(for:in:completion:)` uses that timeline, and a timeline is created for the widget.

In this way, you created an `IntentTimelineProvider`, which is necessary for switching to `IntentConfiguration`.

Make the Switch to IntentConfiguration

Now you are all set to make the switch to `IntentConfiguration`. If you open the **TwitterTrendsWidget.swift** file of the **Widget** folder in the **TwitterTrendsWidget** folder, you will see that `StaticConfiguration` has been used right now in the body of `TwitterTrendsWidget`.

In `TwitterTrendsWidget`, create a variable, `dynamicConfiguration`, by using the code given in Listing 5-7.

Listing 5-7. Creation of a dynamicConfiguration variable

```
var dynamicConfiguration: some WidgetConfiguration {
        IntentConfiguration(kind: kind, intent: TrendsIntent.
        self, provider: TwitterTrendsIntentProvider()) { entry in
            LargeWidgetView(tweets: entry.statuses, title:
            entry.trendTitle)
        }
        .supportedFamilies([.systemLarge])
        .configurationDisplayName("Tweets")
        .description("Tweets Trending Today")
    }
```

In Listing 5-7, a variable named `dynamicConfiguration` is created which returns an `IntentConfiguration` initializer. It uses the value of `TwitterTrendsWidget`'s `kind` variable, `TrendsIntent` as its intent, and the initializer of `TwitterTrendsIntentProvider` as its timeline provider. All the other lines of code are similar to that of the `StaticConfiguration` that exists in the body of `TwitterTrendsWidget`.

Now, replace the body of `TwitterTrendsWidget` with the code given in Listing 5-8.

Listing 5-8. Using dynamicConfiguration in the body of TwitterTrendsWidget

```
var body: some WidgetConfiguration {
        dynamicConfiguration
    }
```

The code given in Listing 5-8 replaces the `StaticConfiguration` with the `dynamicConfiguration` variable that contains `IntentConfiguration`.

Well done! You have switched to `IntentConfiguration`.

Test – Test – Test!

Uninstall all the existing installations of **TwitterTrends** in your device or simulator. Now, select the **TwitterTrends** scheme and run it. To test your widget, add the TwitterTrends widget to your homescreen and try editing it. You should see a configuration screen similar to the one shown in Figure 5-4. Tap on **Choose** to see a screen where you can see a list of trends fetched from Twitter. This screen will look similar to Figure 5-5. From that screen, select any trend and go back to your homescreen. Now, in your widget, you should see the tweets related to that particular trend you had selected.

Awesome job! We hope you had fun.

Summary

Congratulations on making it this far! In this chapter, you learned how you can make your widget fetch data from a server so that you can use those data as configuration options for the parameter in your configurable widget. Some part of this chapter must have been like a revision of the previous chapters to you. And we hope you enjoyed following along and learning. If you have any confusions, please check out the final version of the code by opening the final project folder named **TwitterTrendsFinal** in **TwitterTrends.zip**.

Now you are able to create any kind of widgets – be it a widget that can or cannot be configured or a widget whose parameter has hard-coded configuration options or dynamic configuration options fetched from a server. You have mastered them all.

We wish you luck for the future. Happy coding!

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