Flutter Riverpod 2.0: The Ultimate Guide

#dart #flutter #state-management #riverpod

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Riverpod is a **reactive caching and data-binding framework** that was born as an evolution of the Provider package.

According to the official documentation:

> Riverpod is a complete rewrite of the Provider package to make improvements that would be otherwise impossible.

Many people still view it as a "state management" framework.

But it is much more than that.

In fact, Riverpod 2.0 borrows many valuable concepts from React Query and brings them to the Flutter world.

Riverpod is very versatile, and you can use it to:

- catch programming errors at **compile-time** rather than at runtime
- easily **fetch**, **cache**, and **update** data from a remote source
- perform **reactive caching** and easily update your UI
- depend on **asynchronous or computed state**
- **create**, **use**, and **combine** providers with minimal boilerplate code
- **dispose** the state of a provider when it is no longer used
- write **testable code** and keep your logic outside the widget tree

Riverpod implements well-defined patterns for retrieving and caching data, so you don't have to reimplement them.

And it also helps you establish a good app architecture (if you use it correctly), so you can focus on building features with minimal friction.

Getting started with Riverpod is easy.

But there is a bit of a learning curve if you want to use it to its full capacity, and I've created this guide to cover all the **essential concepts and APIs**.

How this guide is organized

To make it easier to follow, I've organized this guide into three main parts:

1. Why use Riverpod, how to install it, and **core concepts**
2. An overview of the **eight different kinds of providers** (and when to use them)
3. Additional Riverpod features (modifiers, provider overrides, filtering, testing support, logging, etc.)

This guide is **extensive** and **up to date**, and you can use it as a reference in addition to the official documentation.

We'll explore the main Riverpod APIs and concepts **using simple examples**.

Where appropriate, I've included links to **separate** articles covering more complex, real-world examples that didn't fit here.

> A new riverpod_generator package has been published as part of the Riverpod 2.0 release. This introduces a new `@riverpod` annotation API that you can use to automatically generate providers for classes and methods in your code (using code generation). To learn about it, read: How to Auto-Generate your Providers with Flutter Riverpod Generator.

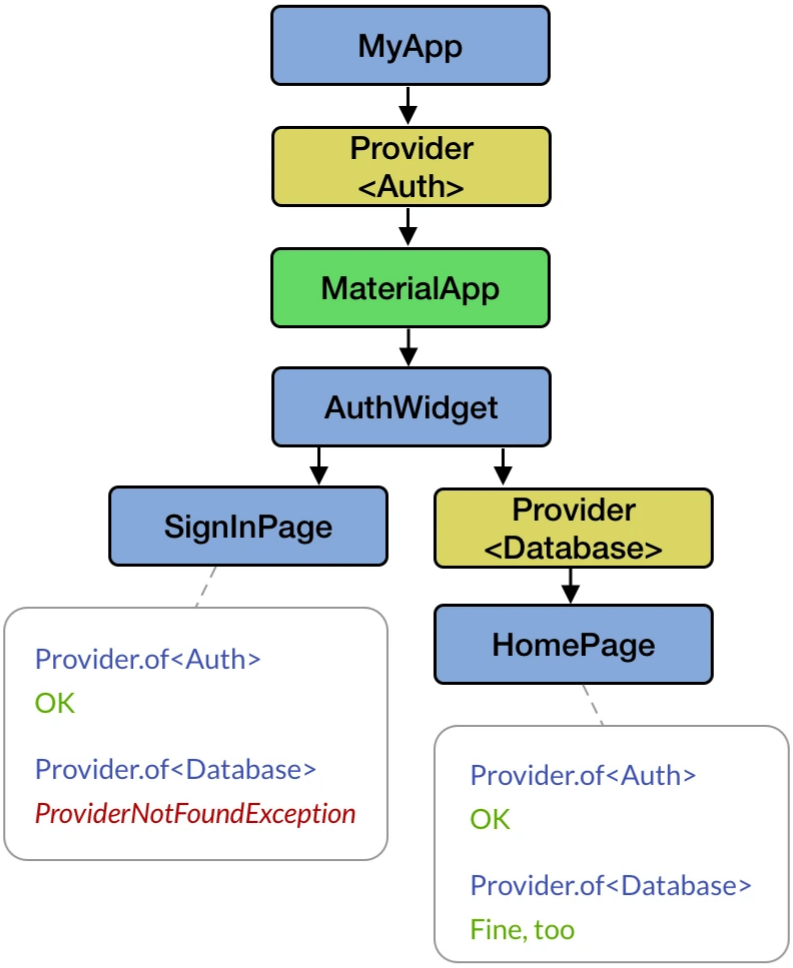
Ready? Let's get started! 🚀

Why use Riverpod?

To understand why we even need Riverpod, let's look at the main drawback of the Provider package.

By design, Provider is an improvement over `InheritedWidget`, and as such, it **depends on the widget tree**.

This is an unfortunate design decision that can lead to the common `ProviderNotFoundException`:



Example: accessing Providers in the widget tree

On the other hand, Riverpod is **compile-safe** since all providers are declared **globally** and can be accessed anywhere.

This means that you can create providers to hold your application state and business logic **outside the widget tree**.

And since Riverpod is a **reactive** framework, it makes it easier to only rebuild your providers and widgets when needed.

So let's see how to install and use it. 👇

Riverpod Installation

The first step is to add the latest version of `flutter_riverpod` as a dependency to our `pubspec.yaml` file:

```yaml
dependencies:
  flutter:
    sdk: flutter
  flutter_riverpod: ^2.0.2
```

> **Note**: If your application already uses flutter_hooks, you can install the hooks_riverpod package instead. This includes some extra features that make it easier to integrate Hooks with Riverpod. In this tutorial, we will focus on flutter_riverpod only for simplicity.

> If you want to use the new Riverpod Generator, you'll need to install some additional packages. For all the details, read: How to Auto-Generate your Providers with Flutter Riverpod Generator.

> **Top Tip**: To more easily add Riverpod providers in your code, install the Flutter Riverpod Snippets extension for VSCode or Android Studio / IntelliJ.

For more info, read the Getting started page on Riverpod.dev.

ProviderScope

Once Riverpod is installed, we can wrap our root widget with a `ProviderScope` :

```dart
void main() {
  // wrap the entire app with a ProviderScope so that widgets
  // will be able to read providers
  runApp(ProviderScope(
    child: MyApp(),
  ));
}
```

`ProviderScope` is a widget that stores the state of all the providers we create.

> Under the hood, `ProviderScope` creates a `ProviderContainer` instance. Most of the time, you won't need to care about `ProviderContainer` or use it directly. To learn more about it, read Flutter Riverpod: How to Register a Listener during App Startup.

Having completed the initial setup, we can start learning about Providers.

What is a Riverpod Provider?

The Riverpod documentation defines a Provider as **an object that encapsulates a piece of state and allows listening to that state.**

With Riverpod, providers are the core of everything:

- They completely replace design patterns such as **singletons**, **service locators**, **dependency injection**, and **InheritedWidgets**.
- They allow you to store some state and easily access it in multiple locations.
- They allow you to optimize performance by filtering widget rebuilds or caching expensive state computations.
- They make your code more testable, since each provider can be overridden to behave differently during a test.

So let's see how to use them. 👇

Creating and Reading a Provider

Let's get started by creating a basic "Hello world" provider:

```
// provider that returns a string value
final helloWorldProvider = Provider<String>((ref) {
  return 'Hello world';
});
```

This is made of three things:

1. **The declaration**: `final helloWorldProvider` is the global variable that we will use to read the state of the provider
2. **The provider**: `Provider<String>` tells us what **kind** of provider we're using (more on this below), and the **type** of the state it holds.
3. **A function** that creates the state. This gives us a `ref` parameter that we can use to read other providers, perform some custom dispose logic, and more.

Once we have a provider, how do we use it inside a widget?

```
class HelloWorldWidget extends StatelessWidget {
  @override
  Widget build(BuildContext context) {
    return Text(
      /* how to read the provider value here? */,
    );
  }
}
```

All Flutter widgets have a `BuildContext` object that we can use to access things **inside the widget tree** (such as `Theme.of(context)`).

But Riverpod providers live **outside the widget tree** and to read them we need an additional **ref** object. Here are three different ways of obtaining it. 👇

1. Using a ConsumerWidget

The simplest way is to use a `ConsumerWidget` :

```
final helloWorldProvider = Provider<String>((_) => 'Hello world');

// 1. widget class now extends [ConsumerWidget]
class HelloWorldWidget extends ConsumerWidget {
  @override
  // 2. build method has an extra [WidgetRef] argument
  Widget build(BuildContext context, WidgetRef ref) {
    // 3. use ref.watch() to get the value of the provider
    final helloWorld = ref.watch(helloWorldProvider);
    return Text(helloWorld);
  }
}
```

By subclassing `ConsumerWidget` instead of `StatelessWidget`, our widget's `build` method gets an extra **ref** object (of type `WidgetRef`) that we can use to **watch** our provider.

Using `ConsumerWidget` is the most common option and the one you should choose most of the time.

2. Using a Consumer

As an alternative, we can wrap our `Text` widget with a `Consumer`:

```
final helloWorldProvider = Provider<String>((_) => 'Hello world');

class HelloWorldWidget extends StatelessWidget {
  @override
  Widget build(BuildContext context) {
    // 1. Add a Consumer
    return Consumer(
      // 2. specify the builder and obtain a WidgetRef
      builder: (_, WidgetRef ref, __) {
        // 3. use ref.watch() to get the value of the provider
        final helloWorld = ref.watch(helloWorldProvider);
        return Text(helloWorld);
      },
    );
  }
}
```

In this case, the "ref" object is one of the `Consumer`'s builder arguments, and we can use it to **watch** the value of the provider.

This works, but it's more verbose than the previous solution.

So when should we use a `Consumer` over a `ConsumerWidget` ?

Here is one example:

```dart
final helloWorldProvider = Provider<String>((_) => 'Hello world');

class HelloWorldWidget extends StatelessWidget {
  @override
  Widget build(BuildContext context) {
    return Scaffold(
      appBar: AppBar(),
      // 1. Add a Consumer
      body: Consumer(
        // 2. specify the builder and obtain a WidgetRef
        builder: (_, WidgetRef ref, __) {
          // 3. use ref.watch() to get the value of the provider
          final helloWorld = ref.watch(helloWorldProvider);
          return Text(helloWorld);
        },
      ),
    );
  }
}
```

In this case, we're wrapping **only** the `Text` with a `Consumer` widget, but **not** the parent `Scaffold` :

```
Scaffold
├─ AppBar
└─ Consumer
    └─ Text
```

As a result, only the `Text` will rebuild if the provider value changes (more on this below).

This may seem like a small detail, but if you have a big widget class with a complex layout, you can use `Consumer` to rebuild **only** the widgets that **depend** on the provider. Though as I said in a previous article:

> Creating widgets that are small and reusable favours composition, leading to code that is concise, more performant, and easier to reason about.

If you follow this principle and create small, reusable widgets, then you'll naturally use `ConsumerWidget` most of the time.

3. Using ConsumerStatefulWidget & ConsumerState

`ConsumerWidget` is a good replacement for `StatelessWidget` and gives us a convenient way of accessing providers with minimal code.

But what if we have a `StatefulWidget` instead?

Here's the same hello world example:

```
final helloWorldProvider = Provider<String>((_) => 'Hello world');

// 1. extend [ConsumerStatefulWidget]
class HelloWorldWidget extends ConsumerStatefulWidget {
  @override
  ConsumerState<HelloWorldWidget> createState() => _HelloWorldWidgetS
}

// 2. extend [ConsumerState]
class _HelloWorldWidgetState extends ConsumerState<HelloWorldWidget>
  @override
  void initState() {
    super.initState();
    // 3. if needed, we can read the provider inside initState
    final helloWorld = ref.read(helloWorldProvider);
    print(helloWorld); // "Hello world"
  }

  @override
  Widget build(BuildContext context) {
    // 4. use ref.watch() to get the value of the provider
    final helloWorld = ref.watch(helloWorldProvider);
    return Text(helloWorld);
    }
  }
```

By subclassing from `ConsumerStatefulWidget` and `ConsumerState`, we can call `ref.watch()` in the `build` method just like we have done before.

And if we need to **read** the provider value in any of the other widget lifecycle methods, we can use `ref.read()`.

> When we subclass from `ConsumerState`, we can access the `ref` object inside all the widget lifecycle methods. This is because `ConsumerState` declares `WidgetRef` **as a property**, much like the Flutter `State` class declares `BuildContext` **as a property that can be accessed directly** inside all the widget lifecycle methods.

> If you use the hooks_riverpod package, you can also use `HookConsumerWidget` and `StatefulHookConsumerWidget`. The official documentation covers these widgets in more detail.

What is a WidgetRef?

As we have seen, we can **watch** a provider's value by using a `ref` object of type `WidgetRef`. This is available **as an argument** when we use `Consumer` or `ConsumerWidget`, and **as a property** when we subclass from `ConsumerState`.

The Riverpod documentation defines `WidgetRef` as **an object that allows widgets to interact with providers**.

Note that there are some similarities between `BuildContext` and `WidgetRef`:

- `BuildContext` lets us access **ancestor** widgets in the widget tree (such as `Theme.of(context)` and `MediaQuery.of(context)`)
- `WidgetRef` lets us access **any** provider inside our app

In other words, **`WidgetRef` lets us access any provider in our codebase** (as long as we import the corresponding file). This is **by design** because all Riverpod providers are **global**.

This is significant because keeping **application** state and logic inside our widgets leads to **poor separation of concerns**. Moving it **inside our providers** makes our code more testable and maintainable. 👍

Eight different kinds of providers

So far, we have learned how to create a simple `Provider` and watch it inside a widget using a `ref` object.

But Riverpod offers **eight different kinds of providers**, all suited for separate use cases:

1. `Provider`
2. `StateProvider` (legacy)
3. `StateNotifierProvider` (legacy)
4. `FutureProvider`
5. `StreamProvider`
6. `ChangeNotifierProvider` (legacy)
7. `NotifierProvider` **(new in Riverpod 2.0)**
8. `AsyncNotifierProvider` **(new in Riverpod 2.0)**

So let's review them and understand when to use them.

> If you use the new riverpod_generator package, you no longer have to declare your providers manually (though I still recommend you get familiar with all six kinds of providers). To learn more, read: How to Auto-Generate your Providers with Flutter Riverpod Generator.

1. Provider

We have already learned about this one:

```dart
// provider that returns a string value
final helloWorldProvider = Provider<String>((ref) {
  return 'Hello world';
});
```

`Provider` is great for accessing dependencies and objects that don’t change.

You may use this to access a repository, a logger, or some other class that **doesn't contain mutable state**.

For example, here's a provider that returns a `DateFormat` :

```dart
// declare the provider
final dateFormatterProvider = Provider<DateFormat>((ref) {
  return DateFormat.MMMEd();
});

class SomeWidget extends ConsumerWidget {
  @override
  Widget build(BuildContext context, WidgetRef ref) {
    // retrieve the formatter
    final formatter = ref.watch(dateFormatterProvider);
    // use it
    return Text(formatter.format(DateTime.now()));
  }
}
```

> `Provider` is great for accessing dependencies that don't change, such as the repositories in our app. For more info, read: Flutter App Architecture: The Repository Pattern.

More info here:

- Provider | Riverpod.dev

2. StateProvider

`StateProvider` is great for storing simple state objects that can change, such as a counter value:

```
final counterStateProvider = StateProvider<int>((ref) {
  return 0;
});
```

If you **watch** it inside the `build` method, the widget will rebuild when the state changes.

And you can update its state inside a button callback by calling `ref.read()` :

```
class CounterWidget extends ConsumerWidget {
  @override
  Widget build(BuildContext context, WidgetRef ref) {
    // 1. watch the provider and rebuild when the value changes
    final counter = ref.watch(counterStateProvider);
    return ElevatedButton(
      // 2. use the value
      child: Text('Value: $counter'),
      // 3. change the state inside a button callback
      onPressed: () => ref.read(counterStateProvider.notifier).state+
    );
  }
}
```

> `StateProvider` is ideal for storing **simple** state variables, such as **enums**, **strings**, **booleans**, and **numbers**. `Notifier` can also be used for the same purpose and is more flexible. For more complex or asynchronous state, use `AsyncNotifierProvider` , `FutureProvider` , or `StreamProvider` as described below.

More info and examples here:

- StateProvider | Riverpod.dev

3. StateNotifierProvider

Use this to listen to and expose a `StateNotifier`.

`StateNotifierProvider` and `StateNotifier` are ideal for managing state that may change in reaction to an event or user interaction.

For example, here's a simple `Clock` class:

```dart
import 'dart:async';

class Clock extends StateNotifier<DateTime> {
  // 1. initialize with current time
  Clock() : super(DateTime.now()) {
    // 2. create a timer that fires every second
    _timer = Timer.periodic(Duration(seconds: 1), (_) {
      // 3. update the state with the current time
      state = DateTime.now();
    });
  }

  late final Timer _timer;

  // 4. cancel the timer when finished
  @override
  void dispose() {
    _timer.cancel();
    super.dispose();
  }
}
```

This class sets the initial state by calling `super(DateTime.now())` in the constructor, and updates it every second using a periodic timer.

Once we have this, we can create a new provider:

```dart
// Note: StateNotifierProvider has *two* type annotations
final clockProvider = StateNotifierProvider<Clock, DateTime>((ref) {
  return Clock();
});
```

Then, we can **watch** the `clockProvider` inside a `ConsumerWidget` to get the current time and show it inside a `Text` widget:

```dart
import 'package:intl/intl.dart';

class ClockWidget extends ConsumerWidget {
  @override
  Widget build(BuildContext context, WidgetRef ref) {
    // watch the StateNotifierProvider to return a DateTime (the stat
    final currentTime = ref.watch(clockProvider);
    // format the time as `hh:mm:ss`
    final timeFormatted = DateFormat.Hms().format(currentTime);
    return Text(timeFormatted);
  }
}
```

Since we're using `ref.watch(clockProvider)`, our widget will rebuild every time the state changes (once every second) and show the updated time.

> **Note**: `ref.watch(clockProvider)` returns the provider's **state**. To access the underlying state notifier object, call `ref.read(clockProvider.notifier)` instead.

For a complete example of how and when to use `StateNotifierProvider`, read this article:

- How to handle loading and error states with StateNotifier & AsyncValue in Flutter

More info here:

- StateNotifierProvider | Riverpod.dev

> As of Riverpod 2.0, `StateNotifier` is considered legacy and can be replaced by the new `AsyncNotifier` class. For more details, read: How to use Notifier and AsyncNotifier with the new Flutter Riverpod Generator.

Note that using `StateNotifierProvider` is overkill if you only need to **read some async data**. That's what `FutureProvider` is for. 👇

4. FutureProvider

Want to get the result from an API call that returns a `Future` ?

Then just create a `FutureProvider` like this:

```
final weatherFutureProvider = FutureProvider.autoDispose<Weather>((re
  // get repository from the provider below
  final weatherRepository = ref.watch(weatherRepositoryProvider);
  // call method that returns a Future<Weather>
  return weatherRepository.getWeather(city: 'London');
});

// example weather repository provider
final weatherRepositoryProvider = Provider<WeatherRepository>((ref) {
  return WeatherRepository(); // declared elsewhere
});
```

> `FutureProvider` is often used with the `autoDispose` modifier. Read below to learn more.

Then you can watch it in the `build` method and use **pattern matching** to map the resulting `AsyncValue` (data, loading, error) to your UI:

```
Widget build(BuildContext context, WidgetRef ref) {
  // watch the FutureProvider and get an AsyncValue<Weather>
  final weatherAsync = ref.watch(weatherFutureProvider);
  // use pattern matching to map the state to the UI
  return weatherAsync.when(
    loading: () => const CircularProgressIndicator(),
    error: (err, stack) => Text('Error: $err'),
    data: (weather) => Text(weather.toString()),
  );
}
```

> **Note**: when you watch a `FutureProvider<T>` or `StreamProvider<T>`, the return type is an `AsyncValue<T>`. AsyncValue is a utility class for dealing with asynchronous data in Riverpod. For more details, read this: Flutter Riverpod Tip: Use AsyncValue rather than FutureBuilder or StreamBuilder

`FutureProvider` is very powerful, and you can use it to:

- perform and cache asynchronous operations (such as network requests)
- handle the error and loading states of asynchronous operations
- combine multiple asynchronous values into another value
- re-fetch and refresh data (useful for pull-to-refresh operations)

More info here:

- FutureProvider | Riverpod.dev

5. StreamProvider

Use `StreamProvider` to watch a `Stream` of results from a realtime API and **reactively** rebuild the UI.

For example, here is how to create a `StreamProvider` for the authStateChanges method of the FirebaseAuth class:

```
final authStateChangesProvider = StreamProvider.autoDispose<User?>((r
  // get FirebaseAuth from the provider below
  final firebaseAuth = ref.watch(firebaseAuthProvider);
  // call a method that returns a Stream<User?>
  return firebaseAuth.authStateChanges();
});
```

```
// provider to access the FirebaseAuth instance
final firebaseAuthProvider = Provider<FirebaseAuth>((ref) {
  return FirebaseAuth.instance;
});
```

And here's how to use it inside a widget:

```
Widget build(BuildContext context, WidgetRef ref) {
  // watch the StreamProvider and get an AsyncValue<User?>
  final authStateAsync = ref.watch(authStateChangesProvider);
  // use pattern matching to map the state to the UI
  return authStateAsync.when(
    data: (user) => user != null ? HomePage() : SignInPage(),
    loading: () => const CircularProgressIndicator(),
    error: (err, stack) => Text('Error: $err'),
  );
}
```

`StreamProvider` has many benefits over the StreamBuilder widget, which are all listed here:

- StreamProvider | Riverpod.dev

6. ChangeNotifierProvider

The `ChangeNotifier` class is part of the Flutter SDK.

We can use it to store some state and notify listeners when it changes.

For example, here's a `ChangeNotifier` subclass along with the corresponding `ChangeNotifierProvider` :

```
class AuthController extends ChangeNotifier {
  // mutable state
  User? user;
  // computed state
  bool get isSignedIn => user != null;

  Future<void> signOut() {
    // update state
    user = null;
    // and notify any listeners
    notifyListeners();
  }
}

final authControllerProvider = ChangeNotifierProvider<AuthController>
  return AuthController();
});
```

And here's the widget `build` method showing how to use it:

```
Widget build(BuildContext context, WidgetRef ref) {
  return ElevatedButton(
    onPressed: () => ref.read(authControllerProvider).signOut(),
    child: const Text('Logout'),
  );
}
```

The `ChangeNotifier` API makes it easy to break two important rules: **immutable state** and **unidirectional data flow**.

As a result, `ChangeNotifier` is discouraged, and we should use `StateNotifier` instead.

> When used incorrectly, `ChangeNotifier` leads to **mutable state** and makes our code harder to maintain. `StateNotifier` gives us a simple API for dealing with **immutable state**. For a more in-depth overview, read: Flutter State Management: Going from setState to Freezed & StateNotifier with Provider

More info here:

- ChangeNotifierProvider | Riverpod.dev

New in Riverpod 2.0: NotifierProvider and AsyncNotifierProvider

Riverpod 2.0 introduced new Notifier and AsyncNotifier classes, along their corresponding providers.

I have covered them separately in this article:

- How to use Notifier and AsyncNotifier with the new Flutter Riverpod Generator

When to use ref.watch vs ref.read?

In the examples above, we have encountered two ways of reading providers: `ref.read` and `ref.watch`.

To get the value of a provider inside a `build` method, we have always used `ref.watch`. This ensures that if the provider value changes, we rebuild the widgets that depend on it.

But there are cases when we shouldn't use `ref.watch`.

For example, inside the `onPressed` callback of a button, we should use `ref.read` instead:

```
final counterStateProvider = StateProvider<int>((_) => 0);

class CounterWidget extends ConsumerWidget {
  @override
  Widget build(BuildContext context, WidgetRef ref) {
    // 1. watch the provider and rebuild when the value changes
    final counter = ref.watch(counterStateProvider);
    return ElevatedButton(
      // 2. use the value
      child: Text('Value: $counter'),
      // 3. change the state inside a button callback
      onPressed: () => ref.read(counterStateProvider.notifier).state+
    );
  }
}
```

As a rule of thumb, we should:

- call `ref.watch(provider)` to **observe** a provider's state in the `build` method and **rebuild** a widget when it changes
- call `ref.read(provider)` to **read** a provider's state **just once** (this can be useful in `initState` or other lifecycle methods)

However, in the code above we have called `ref.read(provider.notifier)` and used it to **modify** its state.

The `.notifier` syntax is available with `StateProvider` and `StateNotifierProvider` **only** and works as follows:

- call `ref.read(provider.notifier)` on a `StateProvider<T>` to return the underlying `StateController<T>` that we can use to modify the state
- call `ref.read(provider.notifier)` on a `StateNotifierProvider<T>` to return the underlying `StateNotifier<T>` so we can call methods on it

> In addition to using `ref.watch` and `ref.read` inside our widgets, we can also use them **inside our providers**. Read below about Combining Providers with

> Riverpod for more info.

Alongside `ref.read` and `ref.watch` , we also have `ref.listen` . 👇

Listening to Provider State Changes

Sometimes we want to show an alert dialog or a `SnackBar` when a provider state changes.

We can do this by calling `ref.listen()` inside the `build` method:

```
final counterStateProvider = StateProvider<int>((_) => 0);

class CounterWidget extends ConsumerWidget {
  @override
  Widget build(BuildContext context, WidgetRef ref) {
    // if we use a StateProvider<T>, the type of the previous and cur
    // values is StateController<T>
    ref.listen<StateController<int>>(counterStateProvider.state, (pre
      // note: this callback executes when the provider value changes
      // not when the build method is called
      ScaffoldMessenger.of(context).showSnackBar(
        SnackBar(content: Text('Value is ${current.state}')),
      );
    });
    // watch the provider and rebuild when the value changes
    final counter = ref.watch(counterStateProvider);
    return ElevatedButton(
      // use the value
      child: Text('Value: $counter'),
      // change the state inside a button callback
      onPressed: () => ref.read(counterStateProvider.notifier).state+
    );
  }
}
```

In this case, the callback gives us the provider's previous and current state, and we can use it to show a `SnackBar` .

> `ref.listen()` gives us a callback that executes **when the provider value changes**, not when the `build` method is called. Hence we can use it to run any **asynchronous** code (such as showing a dialog), just like we do inside button callbacks. For more info about running asynchronous code inside Flutter widgets, read my article about side effects in Flutter.

> In addition to `watch`, `read`, and `listen`, Riverpod 2.0 introduced new methods that we can use to explicitly **refresh** or **invalidate** a provider. I will cover them in a separate article.

Additional Riverpod Features

So far, we have covered most of the core concepts and the six main kinds of providers.

Next up, let's look at some additional features often needed in real-world projects using Riverpod.

The autoDispose modifier

If we're working with `FutureProvider` or `StreamProvider`, we'll want to dispose of any listeners when our provider is no longer in use.

We can do this by adding an `autoDispose` **modifier** to our provider:

```
final authStateChangesProvider = StreamProvider.autoDispose<User?>((r
  // get FirebaseAuth from another provider
  final firebaseAuth = ref.watch(firebaseAuthProvider);
  // call method that returns a Stream<User?>
  return firebaseAuth.authStateChanges();
});
```

This will ensure that the stream connection is closed as soon as we leave the page where we're watching the provider.

> Under the hood, Riverpod keeps track of all the listeners (widgets or other providers) attached to any given provider (either via `ref.watch` or `ref.listen`). If we use `autoDispose`, the provider will be disposed once all listeners are removed (that is, when the widgets are unmounted).

Another use case for `autoDispose` is when we're using `FutureProvider` as a wrapper for an HTTP request that fires when the user opens a new screen.

If we want to cancel the HTTP request when the user leaves the screen before the request is completed, we can use `ref.onDispose()` to perform some custom cancellation logic:

```
final movieProvider = FutureProvider.autoDispose<TMDBMovieBasic>((ref
  // get the repository
  final moviesRepo = ref.watch(fetchMoviesRepositoryProvider);
  // an object from package:dio that allows cancelling http requests
  final cancelToken = CancelToken();
  // when the provider is destroyed, cancel the http request
  ref.onDispose(() => cancelToken.cancel());
  // call method that returns a Future<TMDBMovieBasic>
  return moviesRepo.movie(movieId: 550, cancelToken: cancelToken);
});
```

Caching with Timeout

If desired, we can call `ref.keepAlive()` to preserve the state so that the request won't fire again if the user leaves and re-enters the same screen:

```
final movieProvider = FutureProvider.autoDispose<TMDBMovieBasic>((ref
  // get the repository
  final moviesRepo = ref.watch(fetchMoviesRepositoryProvider);
  // an object from package:dio that allows cancelling http requests
  final cancelToken = CancelToken();
  // when the provider is destroyed, cancel the http request
  ref.onDispose(() => cancelToken.cancel());
  // if the request is successful, keep the response
  ref.keepAlive();
```

```
    // call method that returns a Future<TMDBMovieBasic>
    return moviesRepo.movie(movieId: 550, cancelToken: cancelToken);
  });
```

The `keepAlive` method will tell the provider to keep its state indefinitely, causing it to update only if we **refresh** or **invalidate** it.

We can even use a `KeepAliveLink` to implement a timeout-based caching strategy to dispose the provider's state after a given duration:

```
    // get the [KeepAliveLink]
    final link = ref.keepAlive();
    // start a 30 second timer
    final timer = Timer(const Duration(seconds: 30), () {
      // dispose on timeout
      link.close();
    });
    // make sure to cancel the timer when the provider state is dispose
    // (prevents undesired test failures)
    ref.onDispose(() => timer.cancel());
```

And if you wish to make this code more reusable, you can create an `AutoDisposeRef` extension (as explained here):

```
  extension AutoDisposeRefCache on AutoDisposeRef {
    // keeps the provider alive for [duration] since when it was first
    // (even if all the listeners are removed before then)
    void cacheFor(Duration duration) {
      final link = keepAlive();
      final timer = Timer(duration, () => link.close());
      onDispose(() => timer.cancel());
    }
  }

  final myProvider = Provider.autoDispose<int>((ref) {
    // use like this:
    ref.cacheFor(const Duration(minutes: 5));
    return 42;
  });
```

> Riverpod helps us solve complex problems with simple code, and it really shines when it comes to data caching. To make the most of it, read: Riverpod Data Caching and Providers Lifecycle: Full Guide

The family modifier

`family` is a modifier that we can use to **pass an argument to a provider**.

It works by adding a second **type annotation** and an **additional parameter** that we can use inside the provider body:

```
final movieProvider = FutureProvider.autoDispose
    // additional movieId argument of type int
    .family<TMDBMovieBasic, int>((ref, movieId) async {
  // get the repository
  final moviesRepo = ref.watch(fetchMoviesRepositoryProvider);
  // call method that returns a Future<TMDBMovieBasic>, passing the m
  return moviesRepo.movie(movieId: movieId, cancelToken: cancelToken)
});
```

Then, we can just pass the value we want to the provider when we call `ref.watch` in the `build` method:

```
final movieAsync = ref.watch(movieProvider(550));
```

We could use this when the user selects an item from a `ListView` of movies, and we push a `MovieDetailsScreen` that takes the `movieId` as an argument:

```
class MovieDetailsScreen extends ConsumerWidget {
  const MovieDetailsScreen({super.key, required this.movieId});
  // pass this as a property
```

```
    final int movieId;

    @override
    Widget build(BuildContext context, WidgetRef ref) {
      // fetch the movie data for the given movieId
      final movieAsync = ref.watch(movieProvider(movieId));
      // map to the UI using pattern matching
      return movieAsync.when(
        data: (movie) => MovieWidget(movie: movie),
        loading: (_) => Center(child: CircularProgressIndicator()),
        error: (e, __) => Center(child: Text(e.toString())),
      );
    }
  }
```

Passing multiple parameters to a family

In some cases, you may need to pass **more than one value** to a family.

While Riverpod does **not** support this, you can pass any custom object that implements `hashCode` and the equality operator (such as objects generated with Freezed or objects that use equatable).

For more details, read:

- Passing multiple parameters to a family

To overcome this limitation, you can use the new riverpod_generator package and pass **as many named or positional arguments as you like**. Read this for all the details:

- How to Auto-Generate your Providers with Flutter Riverpod Generator.

Dependency Overrides with Riverpod

Sometimes we want to create a `Provider` to store a value or object that is **not immediately available.**

For example, we can only get a `SharedPreferences` **instance** with a Future-based API:

```
final sharedPreferences = await SharedPreferences.getInstance();
```

But we can't return this inside a **synchronous** Provider:

```
final sharedPreferencesProvider = Provider<SharedPreferences>((ref) {
  return SharedPreferences.getInstance();
  // The return type Future<SharedPreferences> isn't a 'SharedPrefere
  // as required by the closure's context.
});
```

Instead, we have to initialize this provider by throwing an `UnimplementedError` :

```
final sharedPreferencesProvider = Provider<SharedPreferences>((ref) {
  throw UnimplementedError();
});
```

And when the object we need is available, we can set a **dependency override** for our provider inside the `ProviderScope` widget:

```
// asynchronous initialization can be performed in the main method
Future<void> main() async {
  WidgetsFlutterBinding.ensureInitialized();
  final sharedPreferences = await SharedPreferences.getInstance();
  runApp(ProviderScope(
    overrides: [
      // override the previous value with the new object
      sharedPreferencesProvider.overrideWithValue(sharedPreferences),
    ],
    child: MyApp(),
  ));
}
```

The advantage of initializing `sharedPreferences` before calling `runApp()` is that we can watch the `sharedPreferencesProvider` object anywhere without using any Future-based APIs.

> This example used the `ProviderScope` at the root of the widget tree, but we can also create **nested** `ProviderScope` widgets if needed. More on this below.

For a more complex example of asynchronous app initialization, read this article:

- Flutter Riverpod: How to Register a Listener during App Startup

Combining Providers with Riverpod

Providers can **depend on** other providers.

For example, here we define a `SettingsRepository` class that takes an **explicit** `SharedPreferences` argument:

```dart
class SettingsRepository {
  const SettingsRepository(this.sharedPreferences);
  final SharedPreferences sharedPreferences;

  // synchronous read
  bool onboardingComplete() {
    return sharedPreferences.getBool('onboardingComplete') ?? false;
  }

  // asynchronous write
  Future<void> setOnboardingComplete(bool complete) {
    return sharedPreferences.setBool('onboardingComplete', complete);
  }
}
```

Then we create a `settingsRepositoryProvider` provider that **depends** on the `sharedPreferencesProvider` we created above.

```dart
final settingsRepositoryProvider = Provider<SettingsRepository>((ref)
  // watch another provider to obtain a dependency
  final sharedPreferences = ref.watch(sharedPreferencesProvider);
  // pass it as an argument to the object we need to return
  return SettingsRepository(sharedPreferences);
});
```

> Using `ref.watch()` ensures that the provider is updated when the provider **we depend on** changes. As a result, any **dependent** widgets and providers will rebuild too.

Passing Ref as an argument

As an alternative, we can pass `Ref` as an argument when creating the `SettingsRepository`:

```dart
class SettingsRepository {
  const SettingsRepository(this.ref);
  final Ref ref;

  // synchronous read
  bool onboardingComplete() {
    final sharedPreferences = ref.read(sharedPreferencesProvider);
    return sharedPreferences.getBool('onboardingComplete') ?? false;
  }

  // asynchronous write
  Future<void> setOnboardingComplete(bool complete) {
    final sharedPreferences = ref.read(sharedPreferencesProvider);
    return sharedPreferences.setBool('onboardingComplete', complete);
  }
}
```

This way, the `sharedPreferencesProvider` becomes an **implicit** dependency, and we can access it with a call to `ref.read()`.

And this makes our `settingsRepositoryProvider` declaration a lot simpler:

```
final settingsRepositoryProvider = Provider<SettingsRepository>((ref)
  return SettingsRepository(ref);
});
```

> With Riverpod, we can declare providers that contain complex logic or depend on other providers, all **outside** the widget tree. This is a great advantage over the Provider package and makes it easier to write widgets that only contain UI code.

For a real-world example of how to combine providers and handle multiple dependencies in a complex app, read this:

- Flutter App Architecture: The Application Layer

Scoping Providers

With Riverpod, we can **scope** providers so that they **behave differently for a specific part of the application**.

An example of this is when we have a `ListView` that shows a list of products, and each item needs to know the correct product id or index:

```
class ProductList extends StatelessWidget {
  @override
  Widget build(BuildContext context) {
    return ListView.builder(
      itemBuilder: (_, index) => ProductItem(index: index),
    );
  }
}
```

In the code above, we pass the builder's index as a constructor argument to the `ProductItem` widget:

```
class ProductItem extends StatelessWidget {
  const ProductItem({super.key, required this.index});
  final int index;

  @override
  Widget build(BuildContext context) {
    // do something with the index
  }
}
```

This works, but if the `ListView` rebuilds, all of its children will rebuild too.

As an alternative, we can override the provider value inside a **nested** `ProviderScope`:

```
// 1. Declare a Provider
final currentProductIndex = Provider<int>((_) => throw UnimplementedE

class ProductList extends StatelessWidget {
  @override
  Widget build(BuildContext context) {
    return ListView.builder(itemBuilder: (context, index) {
      // 2. Add a parent ProviderScope
      return ProviderScope(
        overrides: [
          // 3. Add a dependency override on the index
          currentProductIndex.overrideWithValue(index),
        ],
        // 4. return a **const** ProductItem with no constructor argu
        child: const ProductItem(),
      );
    });
  }
}

class ProductItem extends ConsumerWidget {
  const ProductItem({super.key});

  @override
  Widget build(BuildContext context, WidgetRef ref) {
    // 5. Access the index via WidgetRef
    final index = ref.watch(currentProductIndex);
    // do something with the index
  }
}
```

In this case:

- We create a `Provider` that throws `UnimplementedError` by default.
- We override its value by adding a parent `ProviderScope` to the `ProductItem` widget.
- We **watch** the index inside the `ProductItem` 's `build` method.

This is better for performance because we can create `ProductItem` as a `const` widget in the `ListView.builder` . So even if the `ListView` rebuilds, our `ProductItem` will **not** rebuild unless its index has changed.

Filtering widget rebuilds with "select"

Sometimes you have a model class with **multiple properties**, and you want to rebuild a widget **only when a specific property changes**.

For example, consider this `Connection` class, along with a provider and a widget class that reads it:

```
class Connection {
  Connection({this.bytesSent = 0, this.bytesReceived = 0});
  final int bytesSent;
  final int bytesReceived;
}

// Using [StateProvider] for simplicity.
// This would be a [FutureProvider] or [StreamProvider] in real-world
final connectionProvider = StateProvider<Connection>((ref) {
  return Connection();
});
```

```
class BytesReceivedText extends ConsumerWidget {
  @override
  Widget build(BuildContext context, WidgetRef ref) {
    // rebuild when bytesSent OR bytesReceived changes
    final counter = ref.watch(connectionProvider).state;
    return Text('${counter.bytesReceived}');
  }
}
```

If we call `ref.watch(connectionProvider)` , our widget will (incorrectly) rebuild when the `bytesSent` value changes.

Instead, we can use `select()` to only listen to a specific property:

```
class BytesReceivedText extends ConsumerWidget {
  @override
  Widget build(BuildContext context, WidgetRef ref) {
    // only rebuild when bytesReceived changes
    final bytesReceived = ref.watch(connectionProvider.select(
      (connection) => connection.state.bytesReceived
    ));
    return Text('$bytesReceived');
  }
}
```

Then, whenever the `Connection` changes, Riverpod will compare the value we're returning (`connection.state.bytesReceived`) and only rebuild the widget if it's different from the previous one.

> The `select` method is available on all Riverpod providers and can be used whenever we call `ref.watch()` or `ref.listen()` . For more info, read Using "select" to filter rebuilds in the Riverpod docs.

Testing with Riverpod

As we've seen, Riverpod providers are **global** but **their state isn't**.

The state of a provider is stored inside a `ProviderContainer` , an object that is implicitly created by `ProviderScope` .

This means that separate widget tests will never share any state, so there is no need for `setUp` and `tearDown` methods.

For example, here is a simple counter application that uses a `StateProvider` to store the counter value:

```
final counterProvider = StateProvider((ref) => 0);

void main() {
  runApp(ProviderScope(child: MyApp()));
}

class MyApp extends StatelessWidget {
  @override
  Widget build(BuildContext context) {
    return MaterialApp(
      home: Consumer(builder: (_, ref, __) {
        final counter = ref.watch(counterProvider);
        return ElevatedButton(
          onPressed: () => ref.read(counterProvider.notifier).state++
          child: Text('${counter.state}'),
        );
      }),
    );
  }
}
```

The code above uses an `ElevatedButton` to show the counter value and increment it via the `onPressed` callback.

When writing widget tests, all we need is this:

```
await tester.pumpWidget(ProviderScope(child: MyApp()));
```

With this setup, multiple tests don't share any state because each test has a different `ProviderScope`:

```
void main() {
  testWidgets('incrementing the state updates the UI', (tester) async
    await tester.pumpWidget(ProviderScope(child: MyApp()));

    // The default value is `0`, as declared in our provider
    expect(find.text('0'), findsOneWidget);
    expect(find.text('1'), findsNothing);

    // Increment the state and re-render
    await tester.tap(find.byType(ElevatedButton));
    await tester.pump();

    // The state have properly incremented
    expect(find.text('1'), findsOneWidget);
    expect(find.text('0'), findsNothing);
  });

  testWidgets('the counter state is not shared between tests', (teste
    await tester.pumpWidget(ProviderScope(child: MyApp()));

    // The state is `0` once again, with no tearDown/setUp needed
    expect(find.text('0'), findsOneWidget);
    expect(find.text('1'), findsNothing);
  });
}
```

How to mock and override dependencies in tests

Many applications need to call REST APIs or communicate with external services.

For example, here is a `MoviesRepository` that we can use to get a list of favourite movies:

```
class MoviesRepository {
  Future<List<Movie>> favouriteMovies() async {
    // get data from the network or local database
  }
}
```

And we can create a `moviesProvider` to get the data we need:

```
final moviesRepositoryProvider = Provider((ref) => MoviesRepository()

final moviesProvider = FutureProvider<List<Movie>>((ref) {
  // access the provider above
  final repository = ref.watch(moviesRepositoryProvider);
  // use it to return a Future
  return repository.favouriteMovies();
});
```

When writing widget tests, we want to replace our `MoviesRepository` with a mock that returns a canned response rather than making a network call.

As we have seen, we can use **dependency overrides** to change the behaviour of a provider by replacing it with a different implementation.

So we can implement a `MockMoviesRepository` :

```
class MockMoviesRepository implements MoviesRepository {
  @override
  Future<List<Movie>> favouriteMovies() {
    return Future.value([
      Movie(id: 1, title: 'Rick & Morty', posterUrl: 'https://nnbd.me
      Movie(id: 2, title: 'Seinfeld', posterUrl: 'https://nnbd.me/2.p
    ]);
  }
}
```

And in our widget tests, we can override the repository provider:

```
void main() {
  testWidgets('Override moviesRepositoryProvider', (tester) async {
    await tester.pumpWidget(
      ProviderScope(
        overrides: [
          moviesRepositoryProvider
              .overrideWithValue(MockMoviesRepository())
        ],
        child: MoviesApp(),
      ),
    );
  });
}
```

As a result, the `MoviesApp` widget will load the data from the `MockMoviesRepository` when the tests run.

> This setup also works if you use mocktail in your tests. You can stub your mock methods to return values or throw exceptions and verify that they are called.

Where to learn more about Testing with Riverpod?

The examples above are quite basic. If you're serious about testing, you'll need some more resources. 👇

The official Riverpod testing guide covers some more details (including how to write unit tests using `ProviderContainer`), but it is not very extensive.

If you have some custom notifiers with dependencies and want to unit-test them, read this:

- How to Unit Test AsyncNotifier Subclasses with Riverpod 2.0 in Flutter

And for a more comprehensive guide about testing with Riverpod (and Flutter in general), you can take my latest course, which contains **over three hours of content about testing alone**:

- The Complete Flutter Course Bundle

Logging with ProviderObserver

Monitoring state changes is beneficial in many apps.

And Riverpod includes a `ProviderObserver` class that we can subclass to implement a `Logger`:

```
class Logger extends ProviderObserver {
  @override
  void didUpdateProvider(
    ProviderBase provider,
    Object? previousValue,
    Object? newValue,
    ProviderContainer container,
  ) {
    print('[${provider.name ?? provider.runtimeType}] value: $newValu
  }
}
```

This gives us access to both the **previous** and **new** value.

We can enable logging for the entire app by adding the `Logger` to the list of observers inside the `ProviderScope`:

```
void main() {
  runApp(
    ProviderScope(observers: [Logger()], child: MyApp()),
  );
}
```

To improve the output of the logger, we can add a name to our providers:

```
final counterStateProvider = StateProvider<int>((ref) {
  return 0;
}, name: 'counter');
```

And if needed, we can tweak the output of the logger based on the observed values:

```
class Logger extends ProviderObserver {
  @override
  void didUpdateProvider(
    ProviderBase provider,
    Object? previousValue,
    Object? newValue,
    ProviderContainer container,
  ) {
    if (newValue is StateController<int>) {
      print(
          '[${provider.name ?? provider.runtimeType}] value: ${newVal
    }
  }
}
```

`ProviderObserver` is versatile, and we can configure our logger to only log values that match a specific **type** or **provider name**. Or we can use a nested `ProviderScope` and only log values inside a particular widget subtree.

This way, we can evaluate state changes and monitor widget rebuilds without putting `print` statements all over the place.

> `ProviderObserver` is similar to the `BlocObserver` widget from the `flutter_bloc` package.

Quick Note about App Architecture with Riverpod

When building complex apps, it's **crucial** to choose a good app architecture that can support your codebase as it grows.

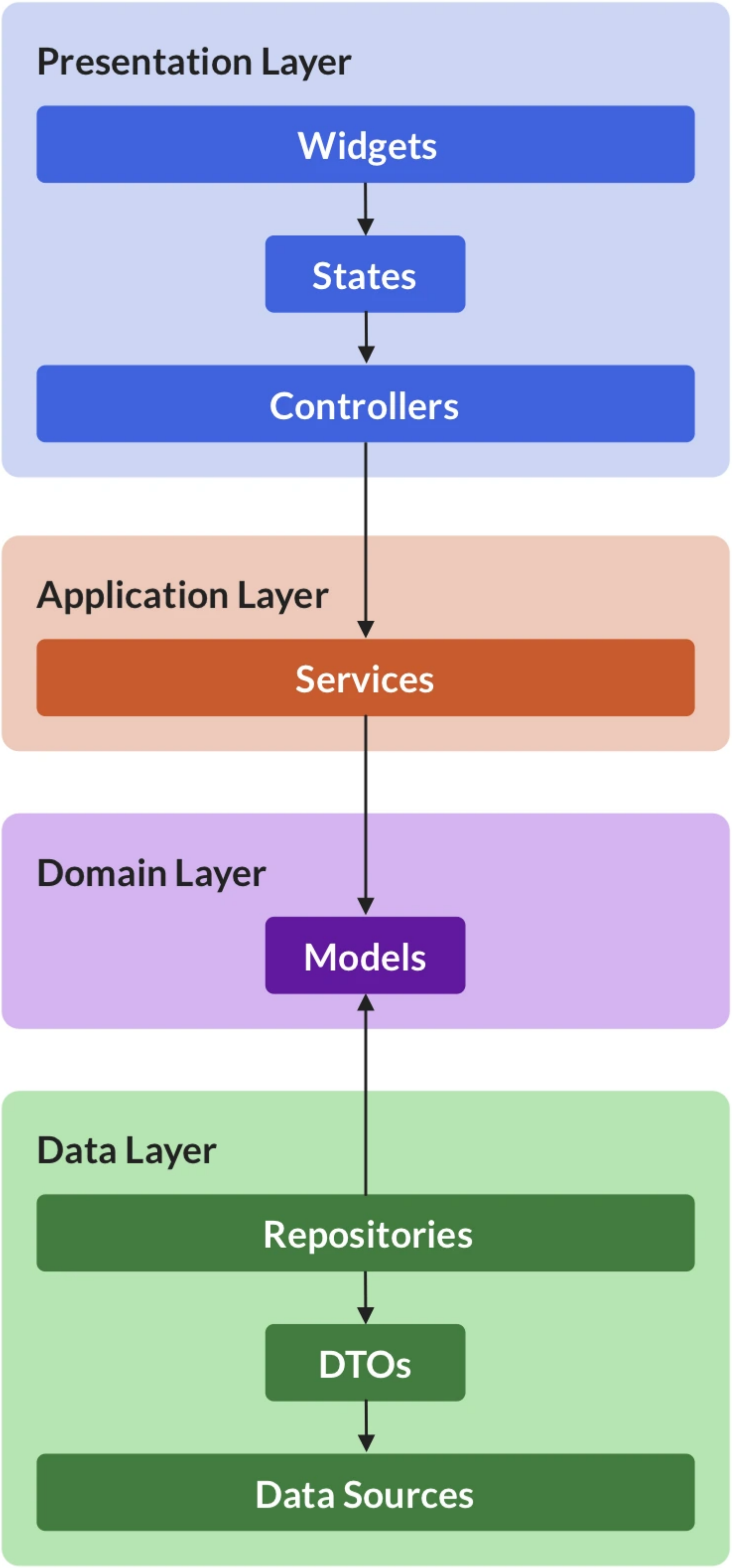
As I said earlier:

- Keeping **application** state and logic inside our widgets leads to **poor separation of concerns**.
- Moving it **inside our providers** makes our code more testable and maintainable.

As it turns out, Riverpod is very well suited to solve architecture problems, **without getting in the way**.

But what does a robust Riverpod app architecture look like?

After a lot of research, I formalized an architecture that is composed of four layers (**data**, **domain**, **application**, **presentation**):



Flutter App Architecture using data, domain, application, and presentation layers. Arrows show the dependencies between layers

I use this architecture extensively in my own apps, and have written an entire series of articles about it.

To learn more, you can get started here: 👇

- Flutter App Architecture with Riverpod: An Introduction

Conclusion

Riverpod borrows the best features of Provider and adds many benefits that make it **easier** and **safer** to manage state in our apps.

In addition to everything we have covered in this guide, I recommend checking the official documentation along with the official example apps:

- Official Riverpod example apps

If you want to build medium-to-large sized apps, I think you'll enjoy my entire series about app architecture with Riverpod:

- Flutter App Architecture with Riverpod: An Introduction

And if you want to go even more in-depth, check out my latest Flutter course where you'll learn how to build a complete eCommerce app with Riverpod 2.0. 👇

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