Test Driven Dart

https://github.com/Yczar/test-driven-dart

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Welcome to Test Driven Dart! This repository is designed to guide Dart developers through the vast landscape of testing in Dart and Flutter, emphasizing a test-driven development (TDD) approach.

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§1.1 Introduction to Testing in Dart

Welcome to the introduction section of Test Driven Dart! Before we dive deep into various testing paradigms, let's establish a foundational understanding of why testing is critical, especially in a language as versatile as Dart.

Why Testing Matters

Testing is not just about ensuring the correctness of code – it's about assuring the quality of the end product, saving costs in the long term, and providing confidence when making changes.

1. **Code Quality Assurance**: Well-tested code tends to have fewer bugs, ensuring that the functionalities are working as expected.

2. **Long-term Savings**: Addressing bugs during development is cheaper than addressing them after the software is released.

3. **Confidence in Refactoring**: With comprehensive tests, developers can make changes without the fear of breaking existing functionalities.

4. **Documentation**: Tests provide an excellent documentation source, as they demonstrate how the code is supposed to work.

Testing in Dart

Dart, with its growing ecosystem and the backing of the Flutter framework, has seen a surge in its user base. This growth makes it even more important to establish robust testing practices.

- **Rich Library Support**: Dart has built-in libraries, such as `package:test`, that provide tools to write unit tests, widget tests, and more.
- **Flexibility**: Dart supports testing for both web and mobile applications, thanks to its versatile runtime.
- **Integrated with Flutter**: For mobile developers using Flutter, Dart's testing capabilities are tightly integrated, allowing for widget testing and UI testing.

Test Driven Development (TDD)

Given our focus on "Test Driven Dart", it's essential to touch upon TDD briefly:
TDD is a software development approach where tests are written before the actual code. The process follows a quick iteration of these three steps:

1. **Write a failing test**: Define what you expect a particular functionality to achieve but don't implement the functionality yet.
2. **Make the test pass**: Implement just enough code to make the test pass.
3. **Refactor**: Once the test is passing, optimize and clean up the code.

In the upcoming sections, we'll dive deeper into TDD, exploring its benefits and seeing it in action with Dart.

Conclusion

Testing is a critical aspect of software development. With Dart, developers have a powerful and flexible platform to write and execute tests across various platforms. As we move forward in this guide, you'll learn the specifics of writing tests in Dart, emphasizing a test-driven approach.
Up next, we'll be setting up our testing environment for Dart. Let's move on!

§1.2 Setting Up Testing Environment for Dart

In this section, we'll walk you through setting up a testing environment for Dart applications. Having a well-configured environment is crucial for smooth test writing and execution.

Prerequisites

Before we begin, make sure you have:

- Dart SDK installed. If not, you can download it from Dart's official website.
- A code editor of your choice. While Dart is supported in many editors, Visual Studio Code and IntelliJ IDEA are recommended due to their excellent Dart and Flutter plugin support.

Step-by-Step Setup

1. Create a New Dart Project (Optional)
If you're starting from scratch:

```
dart create my_test_project
cd my_test_project
```

This will generate a new Dart project in a directory named `my_test_project`.

2. Adding the Test Package
Add the test package to your `pubspec.yaml` under dev_dependencies:

```
dev_dependencies:
  test: ^any_version
```

Run `dart pub get` to install the new dependency.

3. Creating a Test Directory By convention, Dart applications have a 'test' directory at the root level for all test files. If it doesn't exist, create it:

```
mkdir test
```

4. Writing Your First Test Inside the test directory, create a new file named `sample_test.dart` and add the following content:

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

void main() {
  test('String split', () {
    var string = 'foo,bar,baz';
    expect(string.split(','), equals(['foo', 'bar', 'baz']));
  });
}
```

5. Running the Test Navigate to the root directory of your project in the terminal and run:

```
dart test
```

This will execute all tests in the test directory. You should see a message indicating that the test passed.

Tips for a Smooth Testing Experience

- rganize your Tests: As your project grows, consider organizing tests in folders within the test directory based on functionalities or modules.
- Use Descriptive Test Names: Always name your tests descriptively to make it easy for other developers (or future you) to understand the purpose of each test.
- Continuous Integration (CI): Consider setting up a CI pipeline to automatically run tests whenever you push code changes.

Conclusion

Setting up a testing environment for Dart is straightforward, thanks to its well-designed tools and packages. Now that you've laid down the groundwork, you're ready to dive deeper into the world of Dart testing.
In the next section, we'll explore the basic structure of a Dart test. Onward!

§1.3 Basic Test Structure in Dart

Now that we've set up our testing environment, let's delve into the basic structure of a Dart test. Understanding this foundation will aid you as you explore more advanced testing topics.

Anatomy of a Dart Test

A typical Dart test file contains a series of `test` functions that each represent a single test case. Here's a simple breakdown:

1. Import the Test Package

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

This imports the necessary functions and utilities to write tests.

2. Main Function

Every Dart test file begins with a `main` function. It acts as an entry point for the test runner.

```
void main() {
  // Your tests go here
}
```

3. The test Function

The `test` function is where you define individual test cases. It takes two arguments:

- A description of the test (String).
- A callback function containing the test code.

```
test('Description of the test', () {
  // Test code here
});
```

4. Making Assertions with expect

Within the test callback function, you use the `expect` function to assert that a value meets certain criteria.

```
test('String splitting', () {
  var string = 'foo,bar,baz';
  expect(string.split(','), equals(['foo', 'bar', 'baz']));
});
```

In this example, `string.split(',')` is the actual value, and `equals(['foo', 'bar', 'baz'])` is the matcher that defines the expected value.

Grouping Tests

As your testing suite grows, organizing related tests into groups can be beneficial. Use the `group` function:

```
group('String tests', () {
  test('String splitting', () {
    var string = 'foo,bar,baz';
    expect(string.split(','), equals(['foo', 'bar', 'baz']));
});

  // Other string-related tests
```

Conclusion

The basic structure of a Dart test is both intuitive and expressive. As you progress in your Dart testing journey, you'll encounter more advanced utilities and functions to handle diverse scenarios. But the principles we covered in this section will always remain fundamental.
Up next, we'll dive into unit testing in Dart, exploring how to test individual pieces of logic in isolation.
Stay tuned!

§2 Unit Tests

§2.1 Basics of Unit Tests

Unit testing focuses on verifying the correctness of individual units of source code, such as functions or methods, in isolation from the rest of the application. In this section, we'll break down the fundamental concepts and practices of unit testing in Dart.

What is a "Unit"?

In the context of testing, a "unit" refers to the smallest testable part of any software. It can be an entire module or just a single function. The primary goal is to validate that each unit of the software code performs as expected.

Why Unit Testing?

1. **Quick Feedback**: Unit tests are generally fast and can be run frequently, providing immediate feedback to developers.
2. **Improved Design**: Writing tests often leads to better code design and modularity.
3. **Easier Refactoring**: Tests ensure that refactoring doesn't introduce regressions.
4. **Documentation**: Tests can serve as documentation, showcasing how a piece of code is expected to behave.

Writing a Unit Test in Dart

1. Choose the Unit to Test
Decide on a function or method that you want to test. For this example, let's consider a simple function that returns the sum of two numbers:

```dart
int sum(int a, int b) {
  return a + b;
}
```

2. Decide on Test Cases
Think about the different inputs this function can have and what the expected outputs are. For our sum function:

- sum(3, 4) should return 7.
- sum(-3, 4) should return 1.

```
import 'package:test/test.dart';
import 'path_to_your_function.dart';  // Adjust this import path

void main() {
  test('Positive numbers', () {
    expect(sum(3, 4), 7);
  });

  test('Mix of negative and positive numbers', () {
    expect(sum(-3, 4), 1);
  });
}
```

Run the tests using `dart test` in your terminal.

Mocking in Unit Tests

Often, you'll want to test units that have external dependencies like databases or APIs. In unit tests, these dependencies should be isolated using "mocks". Dart's `mockito` package is an excellent tool for this purpose, which we will delve into in a subsequent section.

Best Practices

1. **One Assertion per Test**: Ideally, each test should verify just one behavior.
2. **Descriptive Test Names**: Your test descriptions should explain what the test does, e.g., 'Calculating sum of two positive numbers'.
3. **Test Edge Cases**: Apart from the usual cases, test boundary and unexpected input cases.
4. **Keep Tests Independent**: One test should not depend on another. Each test should be standalone.

Conclusion

Unit tests form the backbone of any software testing strategy. They're vital for ensuring the correctness of individual units of code and building robust applications.

In upcoming sections, we'll explore advanced unit testing techniques, patterns, and tools that are pivotal in Dart.

§3 Widget Tests

§3.1 Introduction to Widget Tests in Flutter

While unit tests verify the correctness of individual units of code, widget tests (also known as component tests) assess individual widgets in isolation. Given that widgets are the central building blocks of Flutter applications, ensuring their correct behavior and rendering is essential. In this section, we will introduce the basics of widget testing in Flutter.

What are Widget Tests?

In Flutter, everything from a button to a screen is a widget. Widget tests ensure that each of these widgets behaves and appears as expected when interacted with. Instead of running the full app, widget tests focus on a single widget, making them more efficient than full app tests but more comprehensive than unit tests.

Setting Up

To write widget tests, you need the `flutter_test` package, which is typically included in the `dev_dependencies` section of your `pubspec.yaml` file:

```
dev_dependencies:
  flutter_test:
    sdk: flutter
```

Writing a Basic Widget Test

1. Import Necessary Libraries
At the beginning of your test file:

```
import 'package:flutter_test/flutter_test.dart';
import 'package:your_app/path_to_your_widget.dart';
```

2. Write the Test
Widget tests use the testWidgets function. Here's an example of testing a simple `RaisedButton`:

```dart
void main() {
  testWidgets('Renders a raised button', (WidgetTester tester)
  ↪  async {
    // Build our app and trigger a frame.
    await tester.pumpWidget(RaisedButton(onPressed: () {}, child:
    ↪  Text('Click me')));

    // Verify if the button is displayed.
    expect(find.byType(RaisedButton), findsOneWidget);
    expect(find.text('Click me'), findsOneWidget);
  });
}
```

3. Run the Test
Use the command:

```
flutter test path_to_your_test_file.dart
```

Interacting with Widgets in Tests

`WidgetTester` provides a multitude of methods to simulate interactions:

- **Tap**: `tester.tap(find.byType(RaisedButton));`
- **Drag**: `tester.drag(find.byType(ListView), Offset(0, -200));`
- **Enter Text**: `tester.enterText(find.byType(TextField), 'Hello Fl
  utter');`

After any interaction, you typically call **tester.pump()** to rebuild the widget tree and reflect changes.

Benefits of Widget Tests

1. **Confidence**: Ensure that changes or refactors don't break your UI.
2. **Speed**: Faster than full app integration tests since they don't involve the entire system.
3. **Documentation**: They serve as documentation, showcasing how a widget is expected to behave and look.

Conclusion

Widget tests are an invaluable tool in the Flutter developer's toolkit. They bridge the gap between unit tests and full app integration tests, offering a middle ground that validates the UI's correctness without the overhead of running the entire app. As you delve deeper into Flutter development, harnessing the power of widget tests will be crucial in building robust, bug-free apps.
In the next sections, we'll explore advanced techniques and best practices in widget testing.
Stay tuned!

§3.2 Mocking Widgets in Flutter

Testing widgets often requires simulating certain behaviors or states that are normally triggered by backend data, user inputs, or other external factors. In many cases, directly interacting with these external factors is either challenging or counterproductive. That's where mocking comes into play. This section provides insights into mocking widgets and their dependencies in Flutter.

The Need for Mocking in Widget Tests

Here are some common scenarios where mocking can be beneficial:

1. **External Dependencies**: Such as API calls, database operations, or third-party services.
2. **User Inputs**: Simulating specific user behaviors without manual intervention.
3. **Specific States**: Testing how a widget behaves under specific conditions, like error states or empty data.

Using mockito with Flutter

`mockito`, which you might be familiar with from Dart unit tests, also plays a crucial role in widget tests. The primary difference lies in how it's used in the context of Flutter's widgets.

Mocking Providers or Services

Imagine you have a widget that fetches user data from an API. You'd likely have a service or provider that manages this. To test the widget in isolation, you'd mock this service or provider.
For a `UserService` that fetches user data:

```
class UserService {
  Future<User> fetchUser(int id) {
    // logic to fetch user from API
  }
}
```

Using `mockito`, create a mock:

```
class MockUserService extends Mock implements UserService {}
```

In your widget test, you can then provide this mock service to your widget using a provider or dependency injection.

Simulating Responses

With the mock service in place, you can dictate its behavior:

```
final userService = MockUserService();

// Mock a successful user fetch
when(userService.fetchUser(1)).thenAnswer((_) async => User(id:
↪  1, name: 'John Doe'));
```

Mocking Widgets

Sometimes, it might be useful to mock entire widgets, especially if they have intricate behaviors or external dependencies themselves. You can achieve this by creating a stub or mock widget to replace the actual widget in tests.

For instance, if you have a custom `MapWidget` that displays a map and you want to avoid rendering it in certain tests, you could replace it with a simpler Placeholder widget.

Testing with Mocked Data

Once your mocks are set up, you can test how your widget reacts to various data scenarios:

```
testWidgets('Displays user data', (WidgetTester tester) async {
  // Use the mocked data setup
  await tester.pumpWidget(MyApp(userService: userService));

  // Check if the user data is displayed
  expect(find.text('John Doe'), findsOneWidget);
});
```

Handling Streams and Change Notifiers

Mocking streams or ChangeNotifier classes requires a bit more setup, but the principle is the same. Using mockito, you can mock the stream or methods on the ChangeNotifier and then check how the widget reacts.

Conclusion

Mocking is an invaluable technique when testing widgets in Flutter. By simulating different data states, user interactions, and external dependencies, you can ensure your widgets are robust and handle various scenarios gracefully. As you continue building more complex apps, these testing techniques will become an essential part of your development workflow.
Up next, delve deeper into advanced widget testing and explore how to test complex UI interactions and flows.

§3.3 Testing Individual Widgets in Flutter

As you venture into the world of Flutter, you'll quickly realize the importance of widgets. They are the building blocks of your application. Testing them ensures that each visual and functional element works as expected. This chapter focuses on the specifics of testing individual widgets.

Why Test Individual Widgets?

- **Precision**: Targets specific widget behaviors without the noise from surrounding elements.
- **Speed**: Faster execution as you're not testing the entire screen or app.
- **Isolation**: Ensures that any bugs or issues are isolated to the widget itself.

Getting Started

To test individual widgets, you'll need the flutter_test package. It offers tools like testWidgets for running widget tests and WidgetTester for interacting with widgets.

```
dev_dependencies:
  flutter_test:
    sdk: flutter
```

Basic Widget Test

The essence of a widget test is to:

1. Create the widget.
2. Add it to the widget tree.
3. Interact with it or check its state.
4. Verify that it behaves and renders as expected.

Example: Testing a Text Widget

```
void main() {
  testWidgets('Displays the correct text', (WidgetTester tester)
  ↪  async {
    await tester.pumpWidget(Text('Hello, Flutter!'));

    expect(find.text('Hello, Flutter!'), findsOneWidget);
  });
}
```

Interactions and Assertions

`WidgetTester` allows you to simulate different interactions like tapping, dragging, and typing. After an interaction, use assertions to check the widget's state.

Example: Testing a RaisedButton

```
void main() {
  testWidgets('Tap on RaisedButton', (WidgetTester tester) async
  ↪ {
    bool wasPressed = false;

    await tester.pumpWidget(
      MaterialApp(
        home: RaisedButton(
          onPressed: () => wasPressed = true,
          child: Text('Tap me!'),
        ),
      ),
    );

    await tester.tap(find.byType(RaisedButton));
    await tester.pump();

    expect(wasPressed, true);
  });
}
```

Advanced Testing Techniques

Using Matchers

Matchers like `findsNothing`, `findsNWidgets(n)`, and `findsWidgets` can help make your assertions more precise. For instance, to check that a widget doesn't exist, use `expect(find.byType(MyWidget), findsNothing)`.

Pumping Widgets

`tester.pump()` triggers a rebuild of the widget tree, reflecting any state changes from the previous frame. In certain cases, you might need `tester.pumpAndSettle()` which repeatedly calls `pump` with the given duration until the widget tree is stable.

Golden Tests

Golden tests (or snapshot tests) involve comparing the widget's rendering with a stored image (a golden file). This helps to check if the UI is rendered correctly

and can be particularly useful for custom painted widgets.

```
await tester.pumpWidget(MyFancyWidget());
await expectLater(find.byType(MyFancyWidget),
 ↪  matchesGoldenFile('golden_file.png'));
```

Conclusion

Testing individual widgets is a pivotal step in ensuring the robustness of your Flutter applications. Given the modular nature of Flutter's widget tree, having confidence in each building block is essential for the overall reliability of your app. In subsequent chapters, dive deeper into integration testing and explore how to ensure complete user flows and interactions are working harmoniously.

§3.4 Advanced Widget Testing Topics in Flutter

After getting comfortable with basic widget testing, you may find a need to test more complex scenarios, or to optimize and refine your test suites. This chapter will explore advanced topics in widget testing to help you address more intricate challenges.

Advanced Interactions

Long Press and Drag

'WidgetTester' offers methods for more complex interactions:

```
await tester.longPress(find.byType(MyWidget)); // Long press
await tester.drag(find.byType(MyWidget), Offset(50, 50)); // Drag
 ↪  by an offset
```

Multi-Touch Gestures

To simulate multi-touch gestures like pinch-to-zoom:

```
final firstLocation = tester.getCenter(find.byType(MyWidget));
final secondLocation = tester.getTopLeft(find.byType(MyWidget));
await tester.zoom(pinchStart: firstLocation, pinchEnd:
 ↪  secondLocation, scale: 2.5);
```

Scrolling Widgets

To test widgets that scroll, like ListView or GridView:

```
await tester.scroll(find.byType(ListView), Offset(0, 500));  //
↪  Scroll by an offset
await tester.fling(find.byType(ListView), Offset(0, -500), 2500);
↪  // Fling/quick scroll
await tester.pumpAndSettle();
```

Testing Animations

Animations might require additional considerations:

- **Pumping Frames**: To move forward in an animation, use `tester.pump(Duration(milliseconds: x))`.
- **Evaluating States**: Check widget states at different points in an animation.

Example of testing a `FadeTransition`:

```
final fadeTransition = FadeTransition(opacity:
↪  animationController, child: MyWidget());
await tester.pumpWidget(fadeTransition);

expect(myWidgetFinder, findsOneWidget);

// Begin the animation
animationController.forward();
await tester.pumpAndSettle();

// Check after animation completes
expect(myWidgetFinder, findsNothing);
```

Custom Matchers

You can create custom matchers to help with more specific test conditions. For example, to check if a widget's size conforms to expected values:

```
Matcher hasSize(Size size) => MatchesWidgetData((widget) =>
↪  widget.size == size);
expect(find.byType(MyWidget), hasSize(Size(100, 100)));
```

Working with Keys

Using keys, especially `ValueKey`, can make finding widgets in tests much easier:

```
final myKey = ValueKey('my_widget_key');
MyWidget(key: myKey);
```

In tests:

```
find.byKey(myKey);
```

This can be especially helpful when differentiating between multiple instances of the same widget type.

Grouping Tests

As your test suite grows, structuring your tests using groups can improve readability:

```
group('FlatButton Tests', () {
  testWidgets('Displays text', (WidgetTester tester) async {
    ...
  });

  testWidgets('Handles onTap', (WidgetTester tester) async {
    ...
  });
});
```

Conclusion

Advanced widget testing in Flutter can seem complex, but by taking advantage of the rich set of tools provided by the framework, you can ensure your UI is robust and responds correctly under various scenarios.
As you dive deeper into the testing ecosystem, remember that the balance between thorough testing and maintainability is crucial. Always aim for tests that are comprehensive yet flexible enough to adapt as your app evolves.
Up next, venture into integration tests to explore comprehensive testing of full app flows and interactions!