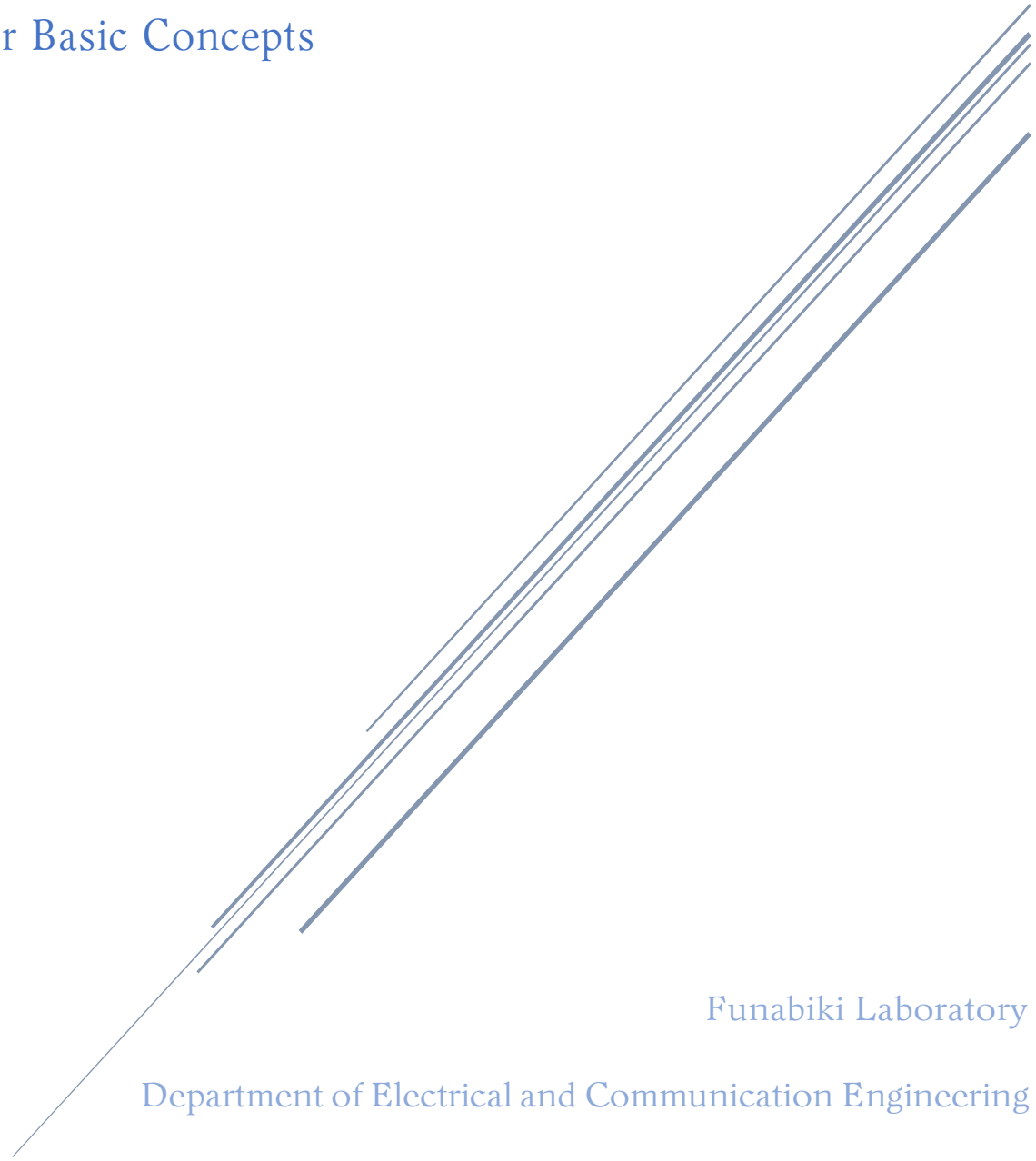
STUDY OF FLUTTER PROGRAMMING LEARNING ASSISTANT SYSTEM

Flutter Basic Concepts



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Flutter Programming Learning Assistant System

Correspondence Between Each Topic and Related CMPs

※ Click the link to go reference pages directly

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What is Dart Language?

Dart is one of the programming languages developed by Google and the official programming language for Flutter. Dart is called an open source and general purpose programming language. Dart was created to meet the development of fast apps for various platforms in the form of a client-optimized language. Which means that Dart provides productive programming for multi-platform development such as mobile, desktop, and web.

Dart was originally used to build the web on Google. The initial goal was to replace JavaScript which was considered to have many disadvantages. After that, the release of Flutter SDK for multi-platform development became a new spotlight on the Dart language.

Dart uses static type checking to ensure that the value of a variable always matches the static type of the variable. This means that the type checking process of a variable is always performed at compile time. This process is performed by the Dart compiler to ensure that the code written will not generate errors at runtime. The code typing system in Dart is also flexible, allowing it to be used with dynamic types that will be combined with runtime checks. Dart also has built-in sound null safety where values cannot be null unless the developer says they can be. With sound null safety, Dart can protect against null exceptions at runtime through static code analysis.

What is Flutter?

Flutter is an SDK (Software Development Kit) developed by Google to make good applications that can run on various platforms. Mobile flutter is a platform that has been widely used by flutter developers to create mobile applications with attractive designs by only utilizing one type of base coding (codebase). That way, the application can be downloaded and used on various platforms, from Android, iOS, website, to desktop.

Applications developed by flutter use the Dart programming language and widgets that are already in this framework. Flutter itself is a widget. Widgets in flutter also support animation and gestures. The logic of the application is based on reactive programming. Widgets in flutter can also have state. By changing the state of the flutter widget, it will automatically perform a comparison between the new and old states. Then the widget will be rendered with the required changes rather than re-rendering the entire widget.

Flutter has been utilized by large companies to create their own mobile applications, such as Alibaba, BMW, and eBay. So, more and more developers are using flutter to help their work to create mobile applications.

Why is Flutter so important?

Flutter is a popular framework used by developers since 2019 although it has actually been developed from 2015. Flutter's popularity is because it uses a programming language called Dart. Dart is easy to understand, learn, and fast. By using flutter, developers can customize the UI appearance and design as desired, so that it can be designed well and uniquely and different from other mobile applications.

Currently, the trend of flutter among developers reaches 46% as a multi-platform framework. In 2023 alone, there were more than 36,889 projects developed using flutter and 11 billion downloads. according to Google Trends analysis, flutter continues to gain popularity year by year, with a significantly increasing trend compared to Kotlin, a native programming language for Android apps. This indicates that developers are increasingly inclined to adopt flutter as their primary choice in mobile app development.

One of the advantages of flutter is that it runs very fast. Flutter is an application development framework that uses the Skia-2D graphic engine which is also used in Chrome and Android. Skia-2D is a powerful and efficient graphics engine, which allows flutter to produce sharp and smooth images on various devices. Flutter's code uses the Dart language, which is a fast, efficient, and easy-to-learn programming language. Dart allows flutter to be compiled to native 32-bit and 64-bit ARM code for iOS and Android. This makes flutter a fast, efficient, and reusable framework.

Flutter is known to be a very productive framework. This is because flutter has a hot-reload feature that allows developers to view compilation results in real-time. This feature is very useful for speeding up application development, because it allows developers to see code changes instantly on the device without the need to wait for the application to restart. The hot-reload feature works by monitoring code changes in flutter files. When any code changes are detected, flutter will compile the changed code and apply the changes to the running application. This process takes place very quickly, so developers can see their code changes instantly on the device.

Flutter is also open source with a BSD license. A BSD (Berkeley Source Distribution) license is one that allows free use, modification, and distribution of software. The BSD license allows commercial use and without any restrictions. The code in flutter comes from the contributions of hundreds of developers from around the world. Many plugins have been created by developers. Each developer can contribute to the development of flutter by reporting bugs/issues or improving existing code. The source code of flutter can be found at the link https://github.com/flutter/flutter.

Feature on Flutter

Flutter is one of the most popular frameworks which includes numerous features when it comes to multi-platform development. Flutter has so many special features that are very useful and popular, but the following will be the most popular features.

- Hot reload
- Single codebase, multi-platform reach
- Expressive UI & Animations
- Native rendering for each platform,
- Rich Ecosystem & Community
- Declarative Programming
- Fast Development & Prototyping
- Future-proof & Evolving

These features enable flutter developers to create beautiful, high-performance, and reusable apps for multiple platforms.

What are the differences and similarities between Flutter and JavaScript?

Flutter and JavaScript are two popular app development frameworks. Both have some things in common. First, both Flutter and JavaScript embrace a familiar landscape. Dart, flutter's language, has similarities to JavaScript in terms of syntax and object-oriented nature. This familiarity makes it easier for JavaScript developers to learn Dart, thus lowering the barrier to entry into the flutter world. Conversely, developers who are already familiar with Dart can utilize their existing knowledge to understand core JavaScript concepts, thereby gaining knowledge for web development.

Flutter and JavaScript also have similarities in terms of cross-platform capabilities. Both can be used to create applications that can run on various devices, such as iOS, Android, web, and desktop. This saves application development time and costs, as developers only need to write code once to run on multiple platforms.

Flutter and JavaScript prioritize rapid iteration and prototyping. Flutter's hot reload feature allows developers to see changes instantly on their devices. Similarly, the dynamic nature of JavaScript enables rapid prototyping and testing in web browsers.

Difference between Flutter and JavaScript

1. Mobile App Development

- **Flutter:** Uses Dart programming and widgets, which can be used to create complex and responsive UIs. Flutter also supports smooth and responsive animations.
- **JavaScript:** HTML is used to define the structure and content of the page, while CSS is used to define the style of the page. JavaScript can also be used to create animations, but not as easily as flutter.

2. Syntax
   - **Flutter:** Similar to JavaScript, but there are some differences, such as the use of data types, operators, and functions.
   - **JavaScript:** JavaScript is a scripting language that has a simple and easy-to-learn syntax.

3. Compilation
   - **Flutter:** Ahead-of-time (AOT) compilation, so Dart code will be compiled into native code for the target platform.
   - **JavaScript:** JavaScript uses interpretation, so JavaScript code will be interpreted by the browser or virtual machine when the application is running.

4. Learning Curve
   - **Flutter:** Has extensive documentation and community, so developers can easily learn flutter.
   - **JavaScript:** Has a low learning curve, as it is a simple and easy-to-learn scripting language.

1. A simple variable declaration

```
var name = 'Dart';
```

Dart allows straightforward variable declaration using "var" or explicit type annotations.

2. Null Safety

Dart embraces null safety, ensuring variables explicitly handle potential nothingness. Null safety introduces 3 key change :

   a. When you specify a type for a variable, parameter, or another relevant component, you can control whether the type allows null. To enable nullability, you add a ? or ! (not recommended to use because will force null variable to non-nullable variable) to the end of the type declaration.

```
String? name //Nullable type.
String name //Non-nullable type.
```

   b. Must initialize variables before using them.

   c. Can't access properties or call methods on an expression with a nullable type.

3. Default value

With null safety, you must initialize the values of non-nullable variables before you use them. You don't have to initialize a local variable where it's declared, but you do need to assign it a value before it's used.

```
int tapCount = 0;
```

4. Final and const

A final variable can be set only once.

```
final name = 'Bob'; //Without a type annotation.
final String longName = 'Bobby';
```

A const variable is a compile-time constant.

```
const bar = 1000000; //Unit of pressure (dynes/cm2)
var foo = const [];
foo = [1, 2, 3]; //Was const []
```

5. Comments usage

A single-line comment begins with //. A multi-line comment begins with /* and ends with */.

```
void main() {
  // TODO: refactor
  print('Welcome back');
 /*
```

```
  Cars car = Cars();
  car.engine();
  car.clean();
  */
}
```

6. Output

   In Dart, you have several options for "displaying" data,

- **Text widget:** Update the text content of a Text widget to show your data.
- **Log:** Use the print function to write data to the console. This is similar to console.log() in JavaScript and is helpful for debugging and inspecting values.
- **Debug tools:** Leverage Flutter's DevTools to inspect variables and data structures interactively.
- **Toasts:** Display temporary messages containing your data using the Toast widget.
- **Custom formatting:** You can format your data before displaying it using Dart's string interpolation and formatting features.

Dart Programming Data Types

The Dart language has special support for the following:

- Numbers (int, double)
- Strings (String)
- Booleans (bool)
- Records ((value1, value2))
- Lists (List, also known as arrays)
- Sets (Set)
- Maps (Map, associates keys and values.)
- Runes (Runes; often replaced by the characters API)
- Symbols (Symbol)
- The value null (Null)

Dart allows you to build objects directly from simple values. Strings like "this is a string" and booleans like true are examples of these "value builders" called literals.

Since everything in Dart is ultimately an object, you can also use constructors to set up variables with specific details. Certain built-in types like maps even have their own dedicated constructors, like Map().

Some other types also have special roles in the Dart language:

- **Object:** The superclass of all Dart classes except Null.
- **Enum:** The superclass of all enums.

- **Future and Stream:** Used in asynchrony support.
- **Iterable:** Used in for-in loops and in synchronous generator functions.
- **Never:** Indicates that an expression can never successfully finish evaluating. Most often used for functions that always throw an exception.
- **dynamic:** Indicates that you want to disable static checking. Usually you should use **Object** or **Object?** instead.
- **void:** Indicates that a value is never used. Often used as a return type.

In Dart also have generic types. The <…> syntax denotes "List" as a parameterized type, allowing it to take on various concrete types through type arguments placed within the brackets. For lists and sets, add <type> before the bracket, and for maps, use <keyType, valueType>. These parameterized literals define the data types allowed within, enhancing both clarity and type safety.

```
var name = <String>['Seto', 'Kathy', 'Lark'];
var views = Map<int, View>();
```

We also used enumerated types. Often called enums, used to represent a fixed number of constant values.

```
enum Color { red, green, blue }; //to declare.
//Using enum like any other static variable.
final favoriteColor = Color.blue;
//get list of all enums value, can also access their index.
List<Color> colors = Color.value;
```

Dart Programming Operators

This table offers a general guide to Dart's operator relationships, showcasing how operators combine values (associativity) and their order of execution (precedence).

Description	Operator	Associativity
unary postfix	*expr++ expr-- () [] ?[] . ?. !*	None
unary prefix	*-expr !expr ~expr ++expr --expr await expr*	None
multiplicative	* / % ~/	Left
additive	+ -	Left
shift	<< >> >>>	Left
bitwise AND	&	Left
bitwise XOR	^	Left
bitwise OR	|	Left
relational and type test	>= > <= < as is is!	None
equality	== !=	None

Correspondence Between Each Topic and Related CMPs

Description	Operator	Associativity
logical AND	`&&`	Left
logical OR	`||`	Left
if null	`??`	Left
conditional	*`expr1 ? expr2 : expr3`*	Right
cascade	`.. ?..`	Left
assignment	`= *= /= += -= &= ^=` *etc.*	Right

1. Arithmetic operators

Operator	Meaning
`+`	Add
`-`	Subtract
`-`*`expr`*	Unary minus, also known as negation (reverse the sign of the expression)
`*`	Multiply
`/`	Divide
`~/`	Divide, returning an integer result
`%`	Get the remainder of an integer division (modulo)

Dart also supports both prefix and postfix increment and decrement operators.

Operator	Meaning
`++`*`var`*	*`var`* `= `*`var`* `+ 1` (expression value is *`var`* `+ 1`)
`var``++`	*`var`* `= `*`var`* `+ 1` (expression value is *`var`*)
`--`*`var`*	*`var`* `= `*`var`* `- 1` (expression value is *`var`* `- 1`)
`var``--`	*`var`* `= `*`var`* `- 1` (expression value is *`var`*)

2. Equality and relational operators

Operator	Meaning
`==`	Equal; see discussion below
`!=`	Not equal
`>`	Greater than
`<`	Less than
`>=`	Greater than or equal to
`<=`	Less than or equal to

This operators will return with bool type of value

3. Type test operator

Operator	Meaning
as	Typecast (also used to specify library prefixes)
is	True if the object has the specified type
is!	True if the object doesn't have the specified type

- Use the as operator to cast an object to a particular type if and only if you are sure that the object is of that type.
- If you aren't sure that the object is of type T, then use is T to check the type before using the object.

4. Assignment operator

=	*=	%=	>>>=	^=
+=	/=	<<=	&=	|=
-=	~/=	>>=		

Here's how compound assignment operators work:

	Compound assignment	Equivalent expression
For an operator *op*:	a *op*= b	a = a *op* b
Example:	a += b	a = a + b

5. Logical operators

Operator	Meaning
!*expr*	inverts the following expression (changes false to true, and vice versa)
||	logical OR
&&	logical AND

Can invert or combine boolean expressions using the logical operators.

6. Bitwise and shift operators

Operator	Meaning
&	AND
|	OR
^	XOR

Operator	Meaning
~expr	Unary bitwise complement (0s become 1s; 1s become 0s)
<<	Shift left
>>	Shift right
>>>	Unsigned shift right

7. Cascade notation

   Dart's cascades (.. and ?..) let you chain operations on a single object, accessing its properties and calling methods in a neat flow. This avoids storing the object in a temporary variable, making your code smoother and more elegant.

   The previous example :

```
var painting = Paint();
painting.color = Colors.black;
painting.strokeWidth = 5.0;
painting.strokeCap = StrokeCap.round;
```

   After cascades :

```
var painting = Paint()
   ..color = Colors.black
   ..strokeWidth = 5.0
   ..strokeCap = StrokeCap.round;
```

   For objects that might be null, initiate your cascade with a null-shorting operator (?..) on the first operation to avoid unnecessary evaluations. Can also nest multiple chains of operations on the same object for even more conciseness. Make sure your cascade starts with a function that actually returns an object, or it will runtime errors.

8. Other operators

Operator	Name	Meaning
`()`	Function application	Represents a function call
`[]`	Subscript access	Represents a call to the overridable `[]` operator; example: `fooList[1]` passes the int `1` to `fooList` to access the element at index `1`
`?[]`	Conditional subscript access	Like `[]`, but the leftmost operand can be null; example: `fooList?[1]` passes the int `1` to `fooList` to access the element at index `1` unless `fooList` is null (in which case the expression evaluates to null)
`.`	Member access	Refers to a property of an expression; example: `foo.bar` selects property `bar` from expression `foo`
`?.`	Conditional member access	Like `.`, but the leftmost operand can be null; example: `foo?.bar` selects property `bar` from expression `foo` unless `foo` is null (in which case the value of `foo?.bar` is null)
`!`	Null assertion operator	Casts an expression to its underlying non-nullable type, throwing a runtime exception if the cast fails; example: `foo!.bar` asserts `foo` is non-null and selects the property `bar`, unless `foo` is null in which case a runtime exception is thrown

Dart Programming Decision Making and Loops

Conditional statement

In Dart we have several conditional statements:

1. If…

   Using if to specify code that needs to be executed if a certain condition is true.

2. else..

   Using else to specify code that needs to be executed if a certain condition is false.

3. else if..

   Using else if to specify a new condition that needs to be executed if the first condition is false.

```
if (isRaining()) {
  bringRainCoat();
} else if (isSnowing()) {
  wearCoat();
} else {
  useSunscreen();
}
```

4. switch..case

   Using switch to select one of many kinds of code specifications that need to be executed.

```
var grade = 'A';
switch(grade) {
  case 'A' : { print("Excellent"); }
  break;
  case 'B' : { print("Good"); }
  break;
  case 'C' : { print("Fair"); }
  break;
  default : { print("Invalid choice"); }
  break;
}
```

In expressing if and else in dart, there are conditional expressions that allow you to concisely evaluate expressions that may require if-else statements:

condition ? expr1 : expr2

If the condition is true, evaluates *expr1* (and returns its value). Otherwise, evaluates and returns the value of *expr2*.

expr1 ?? expr2

If *expr1* is non-null, it returns its value. Otherwise, evaluates and returns the value of *expr2*.

```
var activate = isActive ? 'activate' : 'deactivate';
String playerName(String? name) => name ?? 'Anonymous';
```

Loops

In Dart we have several control flows (loops) :

1. for loops

   You can iterate with the standard for loop. For example:

```
for(int i=0; i<5; i++) {
  print('**');
}
```

   Navigating lists and sets (Iterables) doesn't always require explicit index tracking. For a concise and efficient approach, leverage the for-in loop.

```
for(final player in players) {
  player.training();
}
```

   Iterable classes also offer the forEach() method for functional-style iteration, providing additional flexibility.

```
var someCollection = [1, 2, 3];
someCollection.forEach(print);
```

2. while and do while loops

   A while loop evaluates the condition before the loop :

```
while(!isPlayed()) {
  doSomething();
}
```

   A do-while loop evaluates the condition after the loop :

```
do {
  printLine();
} while(!atEndOfPage());
```

3. break and continue

   Use break to stop looping :

```
while(isStopped()) {
  if (shutDownRequested()) break;
 processIncomingReq();
}
```

   Use continue to skip to the next loop iteration :

```
for(int i = 0; i<players.length; i++) {
  var player=players[i];
  if(player.joinedMonth < 5) {
    continue;
  }
  player.training();
}
```

   If you're using an iterable such as a list or set, how you write the previous example might differ:

```
players
  .where((p) => p.joinedMonth >= 5)
 .forEach((p) => p.training());
```

Dart Programming Function

Functions in Dart are objects, so developers can assign them to variables, send them as arguments, or even call them like classes. They possess a dedicated type ("Function") and can be manipulated like any other data entity.

```
bool isNoble(int atomicNum) {
  return _nobleGases[atomicNum] != null
}
```

For functions that contain just one expression, you can use a shorthand syntax:

```
bool isNoble(int atomicNum) => _nobleGases[atomicNum] != null
```

The => *expr* syntax is a shorthand for { return *expr*; }. The => notation is sometimes referred to as *arrow* syntax.

```
void main() {
  print("Hello World!");
}
```

Every app must have a top-level main() function, which serves as the entrypoint to the app. The main() function returns void and has an optional List<String> parameter for arguments.

Introduction to Flutter Widget

Widgets are the most important thing about flutter. Flutter's UI construction adopts a modern framework heavily influenced by React. Flutter embraces a widget-based approach. Each widget is a self-contained building block with its own visual representation and state, empowering you to build complex UIs from simple, reusable components.

The minimal flutter app simply calls the runApp() function with a widget. The runApp() function takes the given Widget and makes it the root of the widget tree.

```
import 'package:flutter/material.dart';

void main() {
  runApp(
    const Center(
      child: Text(
        'Hello, world!',
        textDirection: TextDirection.ltr,
```

```
        ),
      ),
    );
}
```

Flutter has majorly two types of widget - Stateless and Stateful widgets.

- Stateless widgets : No internal state, update only with parent changes. Build function (responsible to build the widget) is triggered only when the constructor is called.
- Stateful widgets : Have internal state, update with internal or parent changes. Build function is triggered when the constructor is called, also when initState() and setState() are called.

Widgets also can be grouped into multiple categories based on the features :

1. Platform specific widgets

   Flutter caters to each platform's unique design language. Android embraces Material widgets based on Google's Material Design guidelines, while iOS utilizes Cupertino widgets built in accordance with Apple's Human Interface Guidelines.

   a. Examples of Material Widgets :
      - **AppBar :** A Material Design app bar with various options for navigation and actions.
      - **FloatingActionButton :** A Material Design floating action button used for primary actions.
      - **RaisedButton and ElevatedButton :** Buttons styled according to Material Design.
      - **Card :** A Material Design card for displaying content.
      - **TextField :** A text input field with Material Design styling.
      - **ListTile :** A single fixed-height row typically used in lists.
      - **BottomNavigationBar :** A bottom navigation bar for app navigation.

   b. Examples of Cupertino Widgets :
      - **CupertinoNavigationBar :** A navigation bar with iOS-style navigation.
      - **CupertinoButton :** A button styled according to iOS guidelines.
      - **CupertinoTextField :** A text input field with iOS styling.
      - **CupertinoPicker :** A wheel-like picker control often used in iOS.
      - **CupertinoActionSheet :** An iOS-style action sheet for presenting options.

2. Layout widgets

   Flutter facilitates the creation of complex user interfaces through the composition of individual widgets. Many widgets offer built-in layout functions, allowing the arrangement and organization of multiple widgets within a single parent widget.

   a. Single-child layout widgets (Align, Center, Container, Padding, SizedBox, etc)

b. Multi-child layout widgets (Column, Row, GridView, ListView, etc)
c. Sliver widgets (SliverGridDelegate, etc)

3. Platform independent/basic widgets

Flutter provides a large number of basic widgets to create both simple and complex user interfaces in a platform-independent manner. Let's see some of the basic widgets.

MaterialApp

MaterialApp is a widget that is used as the root of the entire flutter app interface. It is the widget that is first built in the widget tree, and governs much of the configuration that affects the entire app. Its key properties :

- title : gives the app a title
- theme : defines the overall theme of the app with ThemeData
- home : defines the widget that will appear first when the application runs.
- routes : defining the various routes in the application
- initialRoute: determines the route that will appear first when the application is running.

Scaffold

Scaffold is a widget used to create a general interface framework that follows Material Design design guidelines. Its key properties :

- appBar : adds an app bar to the page with the AppBar widget.
- Body : places the main widget or page content.
- floatingActionButton : adds a floating action button with the FloatingActionButton widget.
- bottomNavigationBar 7: adds a bottom navigation bar with the BottomNavigationBar widget.
- drawer : adds a side drawer or navigation drawer, which is a panel that can be dragged from the side of the screen to display additional navigation.

AppBar

AppBar is the topmost (or sometimes bottommost) component, contains the toolbar and action buttons, also can provide navigation and information. Its key properties :

- actions : contains a list of widgets as parameters that will be displayed on the app bar behind the title in the form of a row.
- title : adds text or logo in the form of widgets as parameters that will be displayed on the app bar. Can also center the title by making true centerTitle.
- backgroundColor : gives the background color to the app bar.
- elevation : controls the shadow effect displayed below the app bar.
- shape : sets the shape of the app bar and sets the shadow as well.

Bottom Navigation Bar

BottomNavigationBar is a widget that displays a row of small widgets at the bottom of a flutter app. BottomNavigationBar allows you to select one item at a time and quickly navigate to a given page. Its key properties :

- items : required property contains a list of widgets as parameters that will be displayed, using widget of a type BottomNavigationBarItem which contains icon, label and onTap.
- type : sets the type of the bottom navigation bar. There are fixed (when there are less than 4 items) and shifting (when there are 4 or more items).
- currentIndex : initiate the index of the item for the current active BottomNavigationBarItem.

```
MaterialApp(
  title: 'Flutter Demo',
  home: Scaffold(
    appBar: AppBar(
      title: const Text("Home"),
      centerTitle: true,
      actions: const [
        Icon(Icons.add),
        Icon(Icons.menu),
      ],
      elevation: 1,
    ),
    bottomNavigationBar: BottomNavigationBar(
      currentIndex: 0,
      type: BottomNavigationBarType.fixed,
      items: const [
        BottomNavigationBarItem(
          icon: Icon(Icons.home),
          label: 'home',
        ),
        BottomNavigationBarItem(
          icon: Icon(Icons.list_alt),
          label: 'catalog',
        ),
        BottomNavigationBarItem(
          icon: Icon(Icons.person),
          label: 'profile',
        ),
      ],
    ),
    body: Container(),
  ),
);
```

Text

The Text widget displays a string of text with a single style. The style argument is optional. When omitted, the text will use the style from the closest enclosing DefaultTextStyle. Its key properties :

- String data: the content of the text that you want to display on the page.
- style : set the style of the string with the style property and TextStyle class. Can adjust color, font style, font size, font weight, line height, etc.
- textAlign : set the alignment of the text that wants to be displayed.

Widget Text also has a special constructor, Text.rich to display text with various styles and colors in one paragraph.

```
const Text(
  "Let's study Flutter",
  style: TextStyle(
    fontSize: 24,
    fontWeight: FontWeight.bold,
    fontStyle: FontStyle.italic,
    letterSpacing: 5.0,
    color: Colors.redAccent
  ),
  textAlign: TextAlign.justify,
),
```

Container

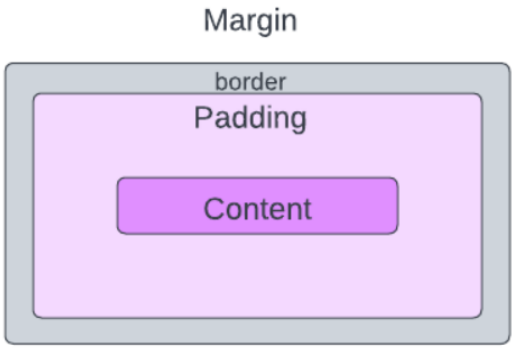
The Container serves as a versatile utility widget in flutter. It handles painting, positioning, and sizing, allowing to easily group and arrange other widgets within the overall UI. Its key properties :

- child : stores its children. The child class can be any widget.
- color : set the background color of the entire container.
- height and width : by default, the container takes as much space as its child needs, but we can also specify the size ourselves.
- margin : to create empty white space around the container. Here we use EdgeInsets to set the margin.
- padding : to create space from the container border to its child. Here we also use EdgeInsets to set it.
- alignment : set the position of the child inside the container. We can align in different ways: bottom, center left, left, right, etc.
- decoration : add decoration to the container by using BoxDecoration class. We can set border, border radius, color, shadow, image, shape, etc.
- transform : helps to rotate the container by using the Transform class.

```
Container(
```

```
  height: 300, width: 300,
  margin: const EdgeInsets.symmetric(vertical: 10),
  padding: const EdgeInsets.all(30),
  alignment: Alignment.topCenter,
  decoration: BoxDecoration(
    color: Colors.blueAccent,
    border: Border.all(width: 2.0, color: Colors.black),
    borderRadius: BorderRadius.circular(20.0),
  )
  child: const Text("Hello Flutter!"),
)
```

Container have properties margin, border, padding, and child (content), which illustrated like this :



Image

Image widgets are used to display images in the application. Image widgets provide various constructors to load images from various sources.

- Image : Generic image loader using ImageProvider class.
- Image.asset : Load image from flutter project's assets.
- Image.file : Load image from system folder
- Image.memory : Load image from memory
- Image.Network : Load image from network

The easiest way to load and display images is to put the images into the assets project.

1. Create an assets folder in the flutter project folder and insert the files you want to use.
2. Assign the assets into pubspec.yaml as follows:

```
flutter:
  assets:
    - assets/car_yellow.png
```

3. Can load and display images to the application by entering the url of the assets.

```
Image.asset('assets/car_yellow.png)
```

output :

TextField

TextField and TextFormField are the most used widgets for user input. They handle various forms of input like email, password, address, etc. To read the user's input, must to initiate the TextEditingController variable and set it as a controller property of TextField widget.

```
final _controller = TextEditingController();
```

Its key properties :

- controller : controls the text being edited. TextEditingController can be used to retrieve the contents of this widget with controller.text, or delete the contents with controller.clear(), etc.
- keyboard type : set the type of input text with TextInputType, can be streetAddress, emailAddress, password etc.
- decoration : add decoration to the text form field by using InputDecoration class. We can set hint text, color, icon, label, error text, etc.
- onChanged : used when the user initiates a change of value in the text field when he has filled or deleted text from the field.

```
TextFormField(
  controller: _controller,
  keyboardType: TextInputType.phone,
  decoration: const InputDecoration(
    hintText: 'Type your phone number',
    icon: Icon(Icons.phone),
  ),
)
```

Button

Buttons are control elements that provide user-triggered events. The standard feature present on every flutter button is :

- Easy addition of different child widgets for different purposes
- Easy assignment of button themes
- Easy addition of themed text and icons
- Providing action functions

Flutter has various kinds of buttons, which are:

- Elevated Button
- Floating Action Button
- Outlined Button
- Icon Button
- Text Button
- Dropdown Button
- PopUp Menu Button

The basic button on a flutter is an elevated button. When an elevated button is pressed, its height will be raised to a certain value. Its key properties :

- child : stores its children. The child class can be any widget. Basically use text widgets or icon widgets.
- onPressed : called when the button is tapped or activated.
- enabled : used to initiate whether the button is enabled or disabled.
- style : customizes the appearance of the button with the ButtonStyle class or the button styleFrom() methods.

```
ElevatedButton(
  onPressed: () {},
  style: const ButtonStyle(
    backgroundColor: MaterialStatePropertyAll<Color>(Colors.teal),
    shadowColor: MaterialStatePropertyAll<Color>(Colors.red),
    elevation: MaterialStatePropertyAll<double>(5.0)
  ),
  child: const Text('Woolha.com'),
)
```

Icon

Icon widget is used to display a glyph from a font described in IconData class using Material icons. Search and find the perfect icon on the Google Fonts website. To use this class, make sure you set uses-material-design: true in your project's pubs6pec.yaml file in the flutter section.

```
const Icon(
  Icons.access_time_filled,
  size: 50.0,
  color: Colors.blueGrey,
  weight: 3.0,
)
```

Card

Card widget is a built-in flutter widget that derives its design from Google's Material Design Library. This widget makes it easy to create a bland space or panel with rounded corners and a slight elevation at the bottom. Its key properties :

- child : takes in a widget as an object to show inside the widget.
- color : set background color to the card.
- elevation : controls the shadow effect displayed below the card.
- margin : to create empty white space around the card. Here we use EdgeInsets to set the margin.
- shape : takes ShapeBorder class as the object to decide the shape of the card.
- borderOnForeground : to set card borders or borderless.

```
Card(
  shape: RoundedRectangleBorder(
    borderRadius: BorderRadius.circular(10.0),
  ),
  elevation: 5.0,
  child: ListTile(
    title: const Text('This is a card with a list tile'),
    leading: const Icon(Icons.card_giftcard),
    trailing: IconButton(
      icon: const Icon(Icons.delete),
      onPressed: () {},
    ),
  ),
)
```

ListTile

ListTile widget is a ui element that is used to display a package of information to make it more compact. Divided into 3 sections, namely start, center, and end. The Start section contains the leading widget, the Center section includes the title and subtitle, and the End section contains the trailing widget. Its key properties :

- title : The primary content of the list tile.
- subtitle : Additional content displayed below the title.
- leading : A widget to display before the title. It can be anything, most will provide an image or icon.
- trailing : A widget to display after the title. It can be anything, most will provide a button.
- isThreeLine : Whether this list tile is intended to display three lines of text.
- onTap : called when the user taps this list tile.

```
ListTile(
  leading: const Icon(Icons.car_rental),
  title: const Text("Car"),
  subtitle: const Text("For car controller"),
  trailing: IconButton(
    icon: const Icon(Icons.more_vert),
    onPressed: () {},
  ),
)
```

DropDownButton

DropDownButton widget is a widget that provides the option to select an item from a list of items. The button shows the currently selected item as well as an arrow that opens a menu for selecting another item. All entries in a given menu must represent values of a consistent type. Usually, an enum is used. Each DropdownMenuItem in the item must be specialized with an argument of the same type. Its key properties :

- items : define various items that are to be defined in our dropdown menu/list. It is a list of items that users can select.
- value : currently selected item.
- style : style text in the dropdown menu/list like color, fontsize, fontweight, etc.
- alignment : defines how the hint or selected item is positioned within the button.
- icon : display an icon to the dropdown button.
- selectedItemBuilder : if we want to display some other text instead of the option selected on the button, we will use selectedItemBuilder.

```
//declare dropdown content in list
final List<String> _items = ['Option 1', 'Option 2', 'Option 3'];
//create dropdown and access _items with .map
DropDownButton(
  items: _items.map((item) {
    return DropdownMenuItem(
      child: Text(item),
      value: item,
    );
  }).toList(),
  onChanged: (value) {
    print('Selected item: $value');
  },
  value: _items[0],
)
```

RadioButton

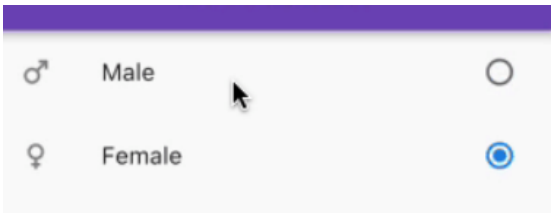
RadioListTile widget is a widget that provides a group of buttons that can select only one of them. This widget uses a generic type, so it needs to provide the generic type before the bracket, usually using enums. Its key properties :

- value : The value represented by this radio button.
- groupValue : currently selected value for this group of radio buttons.
- onChanged : called when the user selects this radio button.
- title & subtitle : The primary content of the list tile.
- activeColor : The color to use when this radio button is selected.

```
//declare radio list with enum
enum Gender { male, female }
Gender? _gender = Gender.male;
```

```dart
//create radio button inside of ListView
ListView(
  children: [
    RadioListTile<Gender>(
      secondary: const Icon(Icons.male),
      controlAffinity: ListTileControlAffinity.trailing,
      title: const Text("Male"),
      value: Gender.male, //asign value
      groupValue: _gender, //asign group
      onChanged: (Gender? value) {
        setState(() => _gender=value); //for change the state
      },
    ),
    RadioListTile<Gender>(
      secondary: const Icon(Icons.female),
      controlAffinity: ListTileControlAffinity.trailing,
      title: const Text("Female"),
      value: Gender.female,
      groupValue: _gender,
      onChanged: (Gender? value) {
        setState(() => _gender=value);
      },
    )
  ],
)
```

Output :



Checkbox

The CheckboxListTile widget is similar to the Radio button, except it allows the user to choose multiple options from several selections. Usually, to save the selected items, we insert them into an empty set. Its key properties :

- value : whether this checkbox is checked or not.
- onChanged : called when the value of the checkbox should change. This is where we give the command to insert the selected items into the created set.
- title & subtitle : the primary content of the list tile.
- secondary : widget to display on the opposite side of the tile from the checkbox.
- controlAffinity : where to place the control relative to the text, it can be ListTile.leading or ListTile.trailing.
- checkColor : color to use for the check icon when this checkbox is checked.

```dart
//declare check box content in list and selected item on set
List<String> languages = ["English", "French", "German"];
```

```
Set<String> selectedItems = {};
//create radio button inside of ListView
ListView(
  children: languages.map((language) {
    bool isChecked = selectedItems.contains(language);
    return CheckboxListTile(
      title: Text(language),
      controlAffinity: ListTileControlAffinity.trailing,
      value: isChecked,
      onChanged: (bool? value) {
        setState(() {
          if(value==true) {
            selectedItems.add(language);
          } else {
            selectedItems.remove(language);
          }
        });
      },
    );
  }).toList(),
)
```

Progress Bar

Progress bars are used to observe how much processing has been done. Flutter provides 2 kinds of progress bars, which are LinearProgressIndicator and CircularProgressIndicator. Basically, the syntax of both is the same, it's just that the shape is different so there are properties to adjust the height that are different. Its key properties :

- value : if non-null, the value of this progress indicator.
- valueColor : progress indicator's color as an animated value.
- LinearProgressIndicator :
  - minHeight : minimum height of the line used to draw the linear indicator.
- CircularProgressIndicator :
  - strokeWidth : width of the line used to draw the circle.

```
CircularProgressIndicator(
  strokeWidth: 10.0,
  value: _progress,
  valueColor: AlwaysStoppedAnimation<Color>(Colors.red),
  backgroundColor: Colors.orange,
)
```

Introduction to Flutter Layouts

Flutter brings the main concept that is entirely using widgets, so the interface of the layout is the widget itself. Flutter develops many widgets that can help in making interfaces. Developers can use layout widgets when composing other widgets.

Types of layout widgets

Layout widgets can be divided into two categories based on the number of child:

- widgets that can only accommodate one child
- widgets that can accommodate multiple children

Single-child layout widgets

A widget will only have one other widget as its child and each widget will have specific functionality. Single-child widgets are very useful for developing high quality widgets having single functionality such as buttons, labels, etc. There are very important single-child layout widgets provided by flutter :

Padding

Padding widget is used to set its child widgets to be given space from surrounding widgets. Padding uses EdgeInsets to set it.

```
Padding(
  padding: EdgeInsets.symmetric(horizontal: 20.0),
  child: Container(
    height: 200, width: 200,
    color: Colors.blueAccent,
    child: const Text("Activate")
  ),
)
```

Align

Align widget is used to set the alignment of its child widget using the value of alignment property. It can also be replaced with the FractionalOffset class, so that it can set a more specific distance. For example: FractionalOffset(1.0, 0.0) represents the top right.

```
Align(
  alignment: Alignment.topRight,
  child: Container(
    height: 200, width: 200,
    color: Colors.blueAccent,
    child: const Text("Activate")
  ),
)
```

SizedBox

SizedBox widget is a basic container defining its child's size, enabling precise layout control from snug placement to strategic spacing.

```
const SizedBox(
  width: 200.0,
  height: 300.0,
  child: const Text("Deactivate"),
)
```

Multi-child layout widgets

Multi-child layout widgets are widgets that have more than one child widget, and each child widget has a different layout. This widget is used to arrange child widgets in a flexible and complex way. There are very important multi-child layout widgets provided by flutter :

Column

Column widgets are widgets that organize children widgets vertically. This widget doesn't scroll (will occur an error if there are more children in the Column than available room).Its key properties :

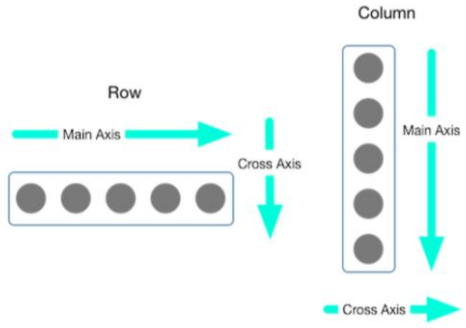
- children : contains a list of all widget that want to display vertically.
- crossAxisAlignment : how the children should be placed along the cross axis. Use the CrossAxisAlignment enum to set this, there are a constructor available :
    - start : place the children with their start edge aligned
    - end : place the children as close to the end of the cross axis as possible
    - center : place the children so that their centers align with the middle of the cross axis.
    - stretch : require the children to fill the cross axis.
    - baseline : place the children along the cross axis such that their baselines match.
- mainAxisAlignment : how the children should be placed along the main axis. Use the MainAxisAlignment enum to set this, there are a constructor available :
    - start : place the children as close to the start of the main axis as possible.
    - end : place the children as close to the end of the main axis as possible.
    - spaceBetween : place the free space evenly between the children.
    - spaceAround : place the free space evenly between the children as well as half of that space before and after the first and last child.
    - spaceEvenly : place the free space evenly between the children as well as before and after the first and last child.
- mainAxisSize : how much space should be occupied in the main axis. Use the MainAxisSize enum to set this, there are 2 values min and max.

Row

Row widget is literally similar to the column widget, except that the row widget organizes the child widgets horizontally. This widget also doesn't scroll (will occur an error if there are more children in the Row than available room). Its key properties :

- children : contains a list of all widget that want to display vertically.
- crossAxisAlignment : how the children should be placed along the cross axis. Use the CrossAxisAlignment enum to set this.
- mainAxisAlignment : how the children should be placed along the main axis. Use the MainAxisAlignment enum to set this.
- mainAxisSize : how much space should be occupied in the main axis. Use the MainAxisSize enum to set this, there are 2 values min and max.

This is a visualization of aligning children widgets for Column and Row. For row, the main axis runs horizontally and the cross axis runs vertically. For column, the main axis runs vertically and the cross axis runs horizontally.




```
Column(
  crossAxisAlignment: CrossAxisAlignment.center,
  children: [
    const Text("Win Hotel"),
    const SizedBox(height: 30),
    Image.asset('assets/win_hotel.jpg'),
    const SizedBox(height: 30),
    Row(
      mainAxisAlignment: MainAxisAlignment.spaceEvenly,
      children: const [
        Icon(Icons.message),
        Icon(Icons.phone),
        Icon(Icons.email)
      ],
    )
  ],
)
```

ListView

ListView is most often used for scrolling widgets. If you have many children in a column then an error can occur due to the screen not having enough space to accommodate them, so

instead of using Column, using ListView widget is the solution. There are 4 various ListView based on their constructor :

- common ListView : creates a scrollable, linear array of widgets from an explicit List.
- ListView.builder : creates a scrollable, linear array of widgets that are created on demand. Often used when retrieving data from the internet or API.
- ListView.custom : creates a scrollable, linear array of widgets with a custom child model.
- ListView.separated : creates a fixed-length scrollable linear array of list "items" separated by list item "separators".

Its key properties :

- childrenDelegate : delegate that provides the children for the ListView. Use the SliverChildDelegate class to set this.
- controller : object that can be used to control the position to which this scroll view is scrolled.
- shrinkWrap : take up only as much vertical space as needed to display its children.
- itemBuilder : callback function is called for each item in the list. It takes two arguments: BuildContext and int index. You're responsible for returning the widget for the item at the given index.
- itemCount : defines the number of items in the list. It specifies how many times the itemBuilder function will be called.

```
//declare contents data in list
final List<String> _data = ['item 1', 'item 2', 'item 3', 'item
4'];
ListView.builder(
  itemCount: _data.length,
  itemBuilder: (context, index) {
    return Container(
      height: 50.0,
      color: Colors.primaries[index % Colors.primaries.length],
      child: Center(
        child: Text(_data[index]),
      ),
    );
  },
)
```

GridView

GridView is also the same as ListView which is used for scrolling widgets. Provides us a widget called GridView which is used to create a scrollable grid of widgets. There are 5 various GridView based on their constructor :

- common GridView : creates a scrollable, 2D array of widgets with a custom SliverGridDelegate.

- GridView.builder : creates a scrollable, 2D array of widgets that are created on demand. Often used when retrieving data from the internet or API.
- GridView.count : creates a scrollable, 2D array of widgets with a fixed number of tiles in the cross axis.
- GridView.custom : creates a scrollable, 2D array of widgets with both a custom SliverGridDelegate and a custom SliverChildDelegate.
- GridView.extent : creates a scrollable, 2D array of widgets with tiles that each have a maximum cross-axis extent.

Its key properties :

- childrenDelegate : delegate that provides the children for the GridView. Use the SliverChildDelegate class to set this.
- controller : object that can be used to control the position to which this scroll view is scrolled.
- gridDelegate : delegate that controls the layout of the children within the GridView. Use the SliverGridDelegate class to set this.
- shrinkWarp : take up only as much horizontal space as needed to display its children.
- itemBuilder : callback function is called for each item in the grid. It takes two arguments: BuildContext and int index. You're responsible for returning the widget for the item at the given index.
- itemCount : defines the number of items in the grid. It specifies how many times the itemBuilder function will be called.
- crossAxisCount : defines the number of columns we want to have in a grid.
- maxCrossAxisExtent : defines maximum item width.

```
//declare contents data in list
final List<String> _data = ['item 1', 'long item 2', 'item 3',
'item 4', 'item 5', 'item 6'];
GridView.builder(
  gridDelegate: SliverGridDelegateWithMaxCrossAxisExtent(
    maxCrossAxisExtent: 150.0, // Max width of each item
    mainAxisSpacing: 10.0, // Spacing between rows
    crossAxisSpacing: 10.0, // Spacing between columns
  ),
  itemCount: _data.length,
  itemBuilder: (context, index) {
    return Container(
      color: Colors.grey[200],
      child: Center(
        child: Text(_data[index]),
      ),
    );
  },
)
```

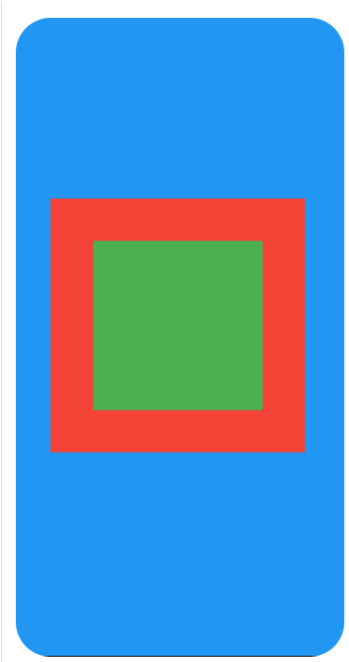
Stack

Stack widgets are used to overlap widgets or layer widgets. The positioned children are then placed relative to the stack according to its top, right, bottom, and left properties. The stack paints its children in order with the first child being at the bottom. If you want to change the order of its children, you can rebuild the stack with the children in a new order. Its key properties :

- children : contains a list of all widget that want to display.
- alignment : align the non-positioned and partially-positioned children in the stack. Use the Alignment enum to set this.
- fit : size the non-positioned children in the stack.
- clipBehavior : content will be clipped (or not) according to this option.

```
Stack(
  alignment: Alignment.center,
  children: [
    Container(
      color: Colors.blue,
    ),
    Container(
      width: 300, height: 300,
      color: Colors.red,
    ),
    Container(
      width: 200, height: 200,
      color: Colors.green,
    ),
  ]
)
```

Output :



ScrollView

If there are not enough widgets on one page but cannot be separated on another page, then a scroll view is needed, so that it can place other widgets below. Flutter has many widgets that support scrolling. In addition to GridView and ListView there are also various other ScrollViews :

- SingleChildScrollView : automatically scrolls its child when necessary.
- CustomScrollView : directly utilize Slivers to create scrolling effects such as lists, grids, and expanding headers.
- NestedScrollView : scrolling view inside of which can be nested other scrolling positions being intrinsically linked.

Here we only need to wrap the widgets that we want to scroll using one of these scrollview widgets. Its key properties :

- child : contains a widget that scrolls.
- controller : object that can be used to control the position to which this scroll view is scrolled.
- physics : how the scroll view should respond to user input. Use ScrollPhysics class to set this.
- reverse : whether the scroll view scrolls in the reading direction.
- scrollDirection : axis along which the scroll view's offset increases.

```
SingleChildScrollView(
  child: Column(
    children: [
      ListView.builder(
        physics: const NeverScrollableScrollPhysics(),
        shrinkWrap: true,
        itemCount: 50,
        itemBuilder: (context, index) {
          return Center(
            child: Container(
              height: 50, width: 200,
              color: Colors.red,
            ),
          );
        },
      ),
    ],
  ),
)
```

In addition to dealing with layout configuration, we can also adjust the size of a widget according to the device used without the need to initiate what device is being used first.

```
Container(
  height: MediaQuery.sizeOf(context).height/3,
  width: MediaQuery.sizeOf(context).width,
```

```
  color: Colors.blueGrey,
  child: const Text("Media Query"),
)
```

Introduction to Flutter Gestures

Developing a program, especially a mobile, website or desktop application, will always expect interaction from users to operate the application. As a framework for creating a multi-platform application, flutter also provides a way to handle gestures from users. Some of the widely used gestures are mentioned here :

- **Tap :** a simple gesture used to select or perform an action. This is done by briefly touching the screen with one finger.
- **Double Tap :** a gesture similar to tap, but performed twice quickly. This is often used to zoom in or out on objects.
- **Drag :** a gesture used to move an object. This is done by touching the screen and then dragging your finger in the desired direction.
- **Flick :** a gesture used to scroll the screen up or down. This is done by touching the screen and then swiping your finger in the desired direction.
- **Pinch :** a gesture used to zoom in or out on an object by bringing two fingers together or apart.
- **Spread/Zoom :** a gesture similar to pinch, but done by moving two fingers separately or together.
- **Panning :** a gesture used to move an object freely. This is done by touching the screen and then dragging your finger in the desired direction without releasing the screen.

Flutter offers a special widget to handle gestures from users, the GestureDetector widget. This widget works by recognizing gestures that have callbacks set and responding accordingly. If a gesture is to be disabled, a null value will be passed to the callback.

There are common gestures captured by the GestureDetector widget and their corresponding events :

- Tap
    - onTapDown : triggered when user makes contact with screen, might be a tap.
    - onTapUp : triggered when the user stops making contact with the screen.
    - onTap : triggered when the user briefly touches the screen.
    - onTapCancel : triggered when the event that fired onTapDown is not a tap.
- Double tap
    - onDoubleTap : triggered when user taps the screen at the same location twice in quick succession.

- Long press
  - onLongPress : triggered when a long press has been detected.
- Vertical drag
  - onVerticalDragStart : triggered when user has made contact with screen and began to move vertically.
  - onVerticalDragUpdate : triggered when contact that is moving vertically has moved in a vertical direction once again.
  - onVerticalDragEnd : triggered when the end of a vertical drag has been detected.
- Horizontal drag
  - onHorizontalDragStart : triggered when user has made contact with screen and began to move horizontally.
  - onHorizontalDragUpdate : triggered when contact that is moving horizontally has moved in a horizontal direction once again.
  - onHorizontalDragEnd : triggered when the end of a horizontal drag has been detected.
- Pan
  - onPanDragStart : triggered when touching the screen and may start moving horizontally or vertically. This callback crashes if onHorizontalDragStart or onVerticalDragStart is set.
  - onPanDragUpdate : triggered when touching the screen and moves the vertical or horizontal direction. This callback crashes if onHorizontalDragUpdate or onVerticalDragUpdate is set.
  - onPanDragEnd : triggered when the previous screen contact is no longer in contact with the screen and moves at a certain speed when it stops contacting the screen. This callback crashes if onHorizontalDragEnd or onVerticalDragEnd is set.

This is an example of using the GestureDetector widget :

```
GestureDetector(
  onTap: () {
    print("You've tapped");
  },
  onDoubleTap: () {
    print("You've double tapped");
  },
  onLongPress: () {
    print("You've long pressed");
  },
  child: Container(
    width: MediaQuery.sizeOf(context).width,
```

```
    height: 200,
    color: Colors.yellow,
  ),
)
```

Flutter also offers a low-level gesture detection mechanism through Listener widget. It will detect all user interactions and dispatches these events :

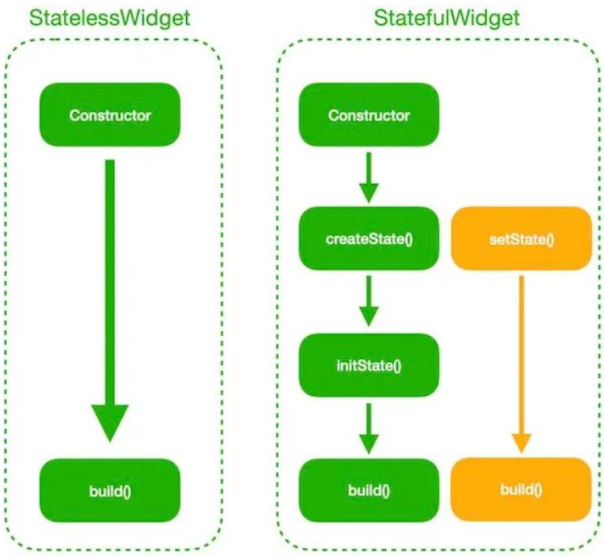
- PointerDownEvent
- PointerMoveEvent
- PointerUpEvent
- PointerCancelEvent

There are also small set of widgets to do specific or advanced gestures.

- Dismissible : support flick gesture to close the widget.
- Draggable : supports dragging gestures to move the widget.
- LongPressDraggable : supports dragging to move the widget, if its parent widget can also be dragged.
- DragTarget : accepts draggable widgets.
- IgnorePointer : hides the widget and its children from the gesture detection process.
- AbsorbPointer : stops the motion detection process itself so that the overlapping widget cannot also participate in the motion detection process and hence, no event is raised.
- Scrollable : supports scrolling of the content available inside the widget

Introduction to Flutter State Management

We certainly know that in flutter two kinds of large groups of widgets are Stateless and Stateful widgets. Both are distinguished by different application lifecycle processes. Here is a visualization of the stateless and stateful lifecycle.



From visualization, it can be taken that stateful has an internal state that is used for internal updates or parent changes.

Before we move on to state management, we want to review the initState() method first. The initState() method is basically the entry point for StatefulWidget. It is only called once and is used in general to initialize the predefined variables of the StatefulWidget. The initState() method is widely overridden because as mentioned earlier, it is only called once during its lifetime.

```
@override
void initState() {
  print("initState Called");
  super.initState();
}
@override
Widget build(BuildContext context) {...}
```

When running the application for the first time, expect to see the initState method triggered, i.e. this method is called first and after that, the control goes into the Build Context.

```
I/flutter (11535): initState Called
I/flutter (11535):  Build method called
```

State management can be divided into two categories based on the duration a particular state lasts in an application.

- **Ephemeral state**

  Lasts for a few seconds like the current state of an animation or a single page like the current product rating. Flutter supports it through StatefulWidget. StatefulWidget provides an option for widgets to create state. State<T> (where T is the inherited widget) when the widget is created for the first time through createState method and then setState method to change the state whenever required. The state change will be done through gestures.

  For the examples we want to create some tabBox class :

  The tabBox class :

  - Manage state for TapBoxx.
  - Defines the active boolean which determines the box's current color.
  - Defines the handleTap() function, which updates active when the box is tapped and calls the setState() function to update the UI.
  - Implements all interactive behavior for the widget.

  The TapBoxx class manages its own state, so it overrides createState() to create a State object. The framework calls createState() when it wants to build the widget. In this class createState() returns an instance of _TapBoxxState.

```
class TapBoxx extends StatefulWidget {
```

```
  const TapBoxx({super.key});

  @override
  State<TapBoxx> createState() => _TapBoxxState();
}
```

The _TapBoxxState class stores the mutable data that can change over the lifetime of the widget.

```
class _TapBoxxState extends State<TapBoxx> {
  bool active = false;

  // ….
}
```

The class also defines a build() method, which creates a GestureDetector and Container for its child. onTap property that defines the callback functions (handleTap) for handling a tap.

```
class _TapBoxxState extends State<TapBoxx> {
  // ...
  @override
  Widget build(BuildContext context) {
    return GestureDetector(
      onTap: handleTap,
      child: Container(
        width: 250, height: 250,
        decoration: BoxDecoration(
          color: active ? Colors.green : Colors.grey
        ),
        alignment: Alignment.center,
        child: Text(
          active ? "Active" : "Inactive",
          style: const TextStyle(
            fontSize: 32, color: Colors.white
          )
        ),
      ),
    );
  }
}
```

The handleTap() method, which is called when the Container is tapped, calls setState(). Calling setState() is critical, because this tells the framework that the widget's state has changed and the widget should be redrawn.

```
void handleTap() {
  setState(() {
    active = !active;
  });
}
```

This is complete code of the TapBoxx class.

```dart
import 'package:flutter/material.dart';

void main() => runApp(const MyApp());

class MyApp extends StatelessWidget {
  const MyApp({super.key});

  @override
  Widget build(BuildContext context) {
    return MaterialApp(
      home: TapBoxx(),
    );
  }
}

class TapBoxx extends StatefulWidget {
  const TapBoxx({super.key});

  @override
  State<TapBoxx> createState() => _TapBoxxState();
}

class _TapBoxxState extends State<TapBoxx> {
  bool active = false;
  void handleTap() {
    setState(() {
      active = !active;
    });
  }
  @override
  Widget build(BuildContext context) {
    return GestureDetector(
      onTap: handleTap,
      child: Container(
        width: 250, height: 250,
        decoration: BoxDecoration(
          color: active ? Colors.green : Colors.grey
        ),
        alignment: Alignment.center,
        child: Text(
          active ? "Active" : "Inactive",
          style: const TextStyle(
            fontSize: 32, color: Colors.white
          )
        ),
      ),
    );
  }
}
```

- **App state**

  Persists for the entire app like logged in user details, cart information, etc. For managing app state, you'll want to research your options. For example, you can use provider, BLoC (Business Logic Component) Pattern with RxDart, GetX, Riverpod, etc.

Riverpod

One of the packages used to manage app state is Riverpod. Some of the advantages of Riverpod flutter include:

1. Support for multiple providers with the same data type.
2. Asynchronous Provider Processing
3. Add Provider from anywhere
4. Can handle loading or error states so as to produce valid values.
5. State inspection in the developer tool in Flutter.

Riverpod can be used in the provided code to manage the dark mode functionality, and its key concepts are :

- Riverpod : dependency injection and state management library for Flutter.
- ProviderScope : wraps the app root widget to make providers available across the app.
- StateNotifierProvider : creates a provider that exposes StateNotifier, a class that manages a single state value and allows updates.
- ConsumerWidget : widget that can listen to the provider and rebuild when its value changes.
- read : method to access the provider value to read its state.
- watch : method to access the provider's value and rebuilds the widget whenever the value changes.

```
import 'package:flutter/material.dart';
import 'package:flutter_riverpod/flutter_riverpod.dart';

// StateNotifier for manage bool value
class ToggleNotifier extends StateNotifier<bool> {
  ToggleNotifier() : super(false);
  void toggle() => state = !state;
}

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

class MyApp extends StatelessWidget {
  @override
  Widget build(BuildContext context) {
    return MaterialApp(
      home: MyHomePage(),
    );
  }
}
```

```
class MyHomePage extends ConsumerWidget {
  @override
  Widget build(BuildContext context, WidgetRef ref) {
    // Read value toggle from provider
    final toggleProvider =
ref.watch(ToggleNotifier.provider);

    return Scaffold(
      appBar: AppBar(
        title: Text('Riverpod Toggle'),
      ),
      body: Center(
        child: Text(
          toggleProvider.state ? 'ON' : 'OFF',
          style: Theme.of(context).textTheme.headline4,
        ),
      ),
      floatingActionButton: FloatingActionButton(
        onPressed: () =>
ref.read(ToggleNotifier.provider).toggle(),
        child: Icon(Icons.toggle_on),
      ),
    );
  }
}
```

Introduction to Flutter Navigation and Routing

In all functional applications that must have many pages to run the workflow, there is a way to switch from one page to another. This method is called Routing. Flutter offers a basic routing class to support workflow in applications.

MaterialPageRoute

The MaterialPageRoute class is used to render the UI by replacing the entire page with a platform-appropriate transition. By default, when a modal route is replaced by another, the previous route remains in memory.

```
MaterialPageRoute(builder: (context) => OtherPage())
```

The most important property is the builder, as it will receive the functionality to build its content by supplying the current application context.

Navigation.push

Navigation.push is used to navigate to a new page using the MaterialPageRoute class.

```
Navigator.push(
 context,
 MaterialPageRoute(builder: (context) => OtherPage()),
```

```
);
```

Navigation.pop

Navigation.pop is used to navigate to the previous page. So if the current page is the very first page of the application, it is not recommended to use Navigate.pop because it will give an error because it does not have the previous page.

```
Navigator.pop(
 context,
 MaterialPageRoute(builder: (context) => OtherPage()),
);
```

Since we are still on the topic of page navigation, we would like to explain two more widgets that are closely related to page navigation.

Dialog

Dialog widgets in flutter appear on the screen to get confirmation regarding important/non-cancellable tasks or inform users about important information about the app.There are two types of flutter dialog :

- AlertDialog : used to get confirmation from users for any critical action they have asked to perform.
- SimpleDialog : used to display a list of options that users can select.

These two flutter dialogs will be wrapped with the showDialog function which requires context and builder arguments. context is taken from the BuildContext in the application while a builder is needed to return the Dialog widget. In addition, the barrierDismissible argument is used to indicate whether tapping on the barrier will dismiss the dialog. It is true by default and can not be null.

```
showDialog(
  context: context,
  builder: (context) => AlertDialog(
    title: const Text("Next Step"),
    content: const Text("Are you sure you want to continue?"),
    actions: [
      TextButton(
        onPressed: () => Navigator.pop(context),
        child: const Text("Cancel"),
      ),
      TextButton(
        onPressed: () {
          print("Continue!");
          Navigator.pop(context);
        },
        child: const Text("Yes"),
      ),
    ],
  ),
)
```

SnackBar

SnackBar widget is a light message with an optional action that is briefly displayed at the bottom of the screen. SnackBar widget should be inside the Scaffold widget because it ensures that important widgets do not overlap. Its key properties :

- content : the primary content of the snack bar.
- margin & padding : create empty space to surround the snack bar, also amount of padding to apply to snack bar's content and optional action.
- width : set width of the snack bar.
- action : action that the user can take based on the snack bar.
- duration : amount of time the snack bar should be displayed.
- showCloseIcon : whether to include a "close" icon widget.

```
Scaffold(
  body: Center(
    child: ElevatedButton(
      onPressed: () {
        final snackBar = SnackBar(
          content: const Text("Snackbar shows"),
          action: SnackBarAction(
            label: "Done",
            onPressed: () {},
          ),
        );
        ScaffoldMessenger.of(context).showSnackBar(snackBar);
      },
     child: const Text('Show SnackBar'),
    ),
  ),
)
```

Navigate Data to Other Pages

Flutter allows various methods to pass data and parameters between multiple screens. However, there are two methods that are most effective and commonly used. These two methods are:

- Passing data using the constructor method.

  The constructor method allows users to specify parameters when initializing classes on the screen. As a result, variables initialized on the source screen can be passed through the destination screen's constructor.

  1. The main screen in this context is the screen where we collect input from the user and forward it to the destination screen using Navigator.push().

```
class ScreenOne extends StatefulWidget {
  @override
  _ScreenOneState createState() => _ScreenOneState();
}
```

```
class _ScreenOneState extends State<ScreenOne> {
  String inputData = '';
  // Further code for inputting the data
}
```

We have a stateful widget called ScreenOne that has an inputData attribute. This variable will be passed to the destination screen later.

2. Here we use MaterialpageRoute to navigate ScreenTwo and pass the constructor inputData.

```
Navigator.push(
  context,
  MaterialPageRoute(
    builder: (context) => ScreenTwo(data: inputData),
  ),
);
```

3. Data can be passed with or without using the @required method in the destination constructor. This indicates whether or not a variable should be assigned a value when creating a class object.

```
class ScreenTwo extends StatelessWidget {
  final String data;

  ScreenTwo({@required this.data});

  // Rest of the code
}
```

- Passing data using the ModalRoute method.

  This method allows us to pass data between screens in Flutter using ModalRoute.of(). Keep defining ScreenOne as in the constructor method. However, we must include the RouteSettings in the Navigator.push method.

  1. By providing the arguments parameter with the desired data, we ensure that the data is accessible within ScreenTwo using the ModalRoute method.

```
Navigator.push(
  context,
  MaterialPageRoute(
    builder: (context) => ScreenTwo(),
    settings: RouteSettings(arguments: inputData),
  ),
);
```

  2. We define the ScreenTwo variable data to store the transmitted data. Using this, we can extract the data from the current page settings and assign it to the data.

```
class ScreenTwo extends StatelessWidget {
  // Rest of the code
```

```
  String? data;

  @override
  Widget build(BuildContext context) {
    data = ModalRoute.of(context)?.settings.arguments
as String?;
    return Scaffold(
      // Rest of the code
    );
  }
}
```

Introduction to Flutter Asynchronous

Asynchronous programming allows tasks or operations to run independently and simultaneously, without waiting for each other to finish before moving on to the next task. In synchronous programming, tasks are executed one by one, and the program waits for each task to complete before moving on to the next. In Asynchronous programming, on the other hand, tasks can be started and executed simultaneously, and the program does not have to wait for the completion of each task. Instead, it can continue executing other tasks or operations while waiting for the result of the asynchronous task.

Future in Dart

Future is a class that initiates a process that will run asynchronously. Future will return a value when the process is complete. Future represents the result of an asynchronous operation and can have 2 states, which are:

- Uncompleted : it means that the future class is waiting for the function's asynchronization operation to complete or throw an error.
- Completed : It can either come with a value or come with an error. Future<int> returns an int value, and Future<String> returns a String value. If the future does not return any value, then the future type is Future<void>. Also if a function fails due to any reason, then the future completes with an error.

  Future has several methods, of which the most commonly used is :
- delayed
- value
- error

This is an example completed future :

```
Future<void> fetchUserOrder() {
  // Case: this function fetching user info from another service
or database.
```

```
  return Future.delayed(const Duration(seconds: 2), () =>
print('Hello World'));
}

void main() {
  fetchUserOrder();
  print('Fetching user order...');
}
```

FutureBuilder

There is a widget that builds itself based on recent snippets of interaction with Future, the FutureBuilder. If the future is not finished, FutureBuilder will display the specified widget as a "placeholder", and if the future is finished, FutureBuilder will create a widget corresponding to the future result. Its key properties :

- future : represents the future that will be used by FutureBuilder to determine the condition whether the data is available or not.
- initialData : this property represents the data that will be used to build the snapshot until a non-zero Future has been completed.
- builder : callback that is used to build the widget according to the Future result. This callback will receive two parameters namely BuildContext and AsyncSnapshot.
- key : controls how other widgets replace one widget.

```
FutureBuilder<String>(
  future: fetchData(), // Replace with actual future
  builder: (context, snapshot) {
    if (snapshot.hasData) {
      return Text(snapshot.data!); // Display the fetched data
    } else if (snapshot.hasError) {
      return Text("${snapshot.error}"); // Display error message
    } else {
      return CircularProgressIndicator(); // A loading indicator
    }
  },
)
```

Async and Await in Dart

This is a feature that allows us to add asynchronous code that behaves like synchronous code, making it easier to read. When a function is marked with async, it signifies that the function will do some work that can take some time and will return a future object that wraps the result of that work.

```
void main() {
  print("Start");
  getData();
  print("End");
}

void getData() async{
```

```
  String data = await middleFunction();
  print(data);
}

Future<String> middleFunction(){
  return Future.delayed(Duration(seconds:5), ()=> "Hello");
}
```

On the other hand, the await keyword allows you to delay the execution of an asynchronous function until the awaited future is finished. This allows us to create code that looks synchronous but is actually asynchronous.

When you await for an asynchronous function, code execution inside the caller will be suspended while the async operation is executed. When the operation is complete, the value of what was waited for is contained in the future object. Important Concept are :

- To define an Asynchronous function, add async before the function body.
- The await keyword only works in asynchronous functions.

Handling Errors

To handle errors in an async function, use try-catch. try is the initial step to execute exception handling. While catch is used to receive the error.

```
try {
  breedMoreLlamas();
} catch (e) {
  print('Error: $e'); // Handle the exception first.
} finally {
  cleanLlamaStalls(); // Then clean up.
}
```

So the way it works is that first the code block inside the try will be executed first. When an error occurs, it will immediately jump to the catch block. Also it sometimes may use finally, to ensure that some code runs whether or not an exception is thrown, if no catch clause matches the exception, the exception is propagated after the finally clause runs.

There are many types of exceptions in Flutter, one of which is a Flutter-specific exception, that is a platform exception. This exception is often encountered when dealing with platform-specific code, such as making native platform calls. This can include errors related to device features, such as camera access, permissions, or location, etc.

Introduction to Flutter Animation

By implementing animation, we can enhance the user experience when using our application. Otherwise, if we don't implement an animation, the app will look stiff. As a result, users get bored quickly and may decide to uninstall the app from their devices.

In most applications, animations are defaulted to page transitions within the application. The animation also varies depending on the framework on each device platform.

For applications developed with Flutter, there are built-in animations that we can directly use to beautify and help us to enhance the user experience.

Animation

Animation class generates a value interpolated between 2 numbers for a certain duration. An animation consists of a value (of type T) along with a state. Most common Animation classes are :

- Animation<double> : interpolate values between two decimal numbers.
- Animation<Color> : interpolate colors between two color
- Animation<Size> : interpolate sizes between two sizes

To create a new animation that you can run forward and backward, consider using AnimationController. AnimationController generates new values whenever the application is ready for a new frame. It supports linear based animation and the value starts from 0.0 to 1.0.

```
controller = AnimationController(duration: const Duration(seconds:
2), vsync: this);
```

This is a controller variable that controls the animation and duration option controls the duration of the animation process. vsync is a special option used to optimize the resource used in the animation.

AnimatedContainer

AnimatedContainers allow you to specify the width, height, background color, and more. However, when an Animated Container is rebuilt with a new property, it is automatically animated between the old and new values. In Flutter, this type of animation is known as "implicit animation".

1. Create a StatefulWidget with default properties

```
class Animate extends StatefulWidget {
 const Animate({Key? key}) : super(key: key);

 @override
 State<Animate> createState() => _AnimateState();
}

class _AnimateState extends State<Animate> {
 Color _color = Colors.green;
 BorderRadiusGeometry _radius = BorderRadius.circular(8);
 @override
 Widget build(BuildContext context) {
   //Fill this code
 }
}
```

2. Build an AnimatedContainer using the property and pass a duration parameter that specifies how long the animation should run.

```
AnimatedContainer(
  width: 50, height: 50,
  decoration: BoxDecoration(color: _color, borderRadius:
_radius),
  duration: const Duration(seconds: 1),
  curve: Curves.fastOutSlowIn,
)
```

3. Start the animation by rebuilding with the new property by utilizing setState().

   For example, you can add a button to the app. When the user taps the button, update the properties with the new width, height, background color, and border radius inside the call to setState().

```
FloatingActionButton(
  onPressed: () {
    setState(() {
      final random = Random();
      _color = Color.fromRGBO(
        random.nextInt(256), random.nextInt(256),
        random.nextInt(256),
        1
      );
      _radius =
      BorderRadius.circular(random.nextInt(100).toDouble());
    });
  },
  child: const Icon(Icons.play_arrow),
)
```

Hero

If there is the same visual feature on 2 pages, it is helpful to direct the user to have the feature physically move from one page to another during the page transition. This kind of animation is called a hero animation. The hero widget "flies" on the Navigator overlay during the transition and while it is flying, it is by default not displayed in its original location on the old page and the new page.

To label widgets as such features, wrap them with Hero widgets. When navigation occurs, the Hero widgets on each route are identified by the HeroController. For each pair of Hero widgets that have the same tag, the hero animation is triggered. Its key properties :

- tag : the identifier, if this hero tag matches the hero tag on the PageRoute we are navigating to or from, then the hero animation will be triggered.
- child : a widget subtree that will "fly" from one page to another during a Navigator push or pop transition.

```
Hero(
  tag: 'hero-tag',
```

```
  child: Container(
    width: 200,
    height: 200,
    color: Colors.blue,
  ),
),
```

Tween

A type of animation that gradually changes the value of a property over time. It can be used to animate the position, size, color, or other properties of a widget. Tween animations are created by using a combination of the Tween class and AnimationController. The Tween class defines the start and end values of the animation. The AnimationController class controls the duration and playback of the animation. Its key properties for each component that used to arrange tween animation code :

1. AnimationController : Controls the animation's progression, duration, and playback.
    - Key properties :
        - vsync : Links the controller to a vsync provider for efficient frame updates (provided by SingleTickerProviderStateMixin).
        - duration : Sets the total time for the animation to complete (3 seconds in this case).
2. Tween : Defines the starting and ending values for an animation.
    - Key properties :
        - begin : The initial value of the animation (Offset(-1, 0), meaning items start offscreen to the left).
        - end : The final value of the animation (Offset.zero, meaning items slide into their final positions).
3. CurvedAnimation : Applies a non-linear curve to the animation's progression, customizing its easing.
    - Key properties :
        - parent : The parent controller driving the animation (AnimationController).
        - curve : The specific curve to apply (Interval in this case, to stagger item animations).
4. SlideTransition : Applies a sliding transition to a widget based on an Animation<Offset>.
    - Key properties :
        - position : The animation controlling the offset of the widget (used for sliding items).

The way to use tween animation :

1. Create Stateful Widget
2. The state class extends SingleTickerProviderStateMixin to provide a vsync provider for efficient animation handling.

```
class Animate extends StatefulWidget {
  const Animate({Key? key}) : super(key: key);

  @override
  State<Animate> createState() => _AnimateState();
}

class _AnimateState extends State<Animate>
    with SingleTickerProviderStateMixin {
  late AnimationController _controller;
  late Animation<Offset> animation;
  @override
  Widget build(BuildContext context) {
   //Fill the code
  }
}
```

3. Initialize AnimationController, inside initState, create AnimationController instance :
   - vsync: this links it to the vsync provider.
   - duration: Duration(seconds: 2) sets the animation duration to 2 seconds.
4. Define an Animation<Offset> using Tween and CurvedAnimation
   - Tween<Offset>(begin: Offset(1, 0), end: Offset.zero) sets the start and end offsets for the slide transition (from offscreen right to center).
   - CurvedAnimation(parent: _controller, curve: Curves.easeInOut) applies a smooth easing curve to the animation.

```
@override
void initState() {
  super.initState();
  _controller = AnimationController(
    vsync: this,
    duration: Duration(seconds: 2),
  );
  animation = Tween<Offset>(begin: Offset(1, 0),
    end: Offset.zero).animate(
    CurvedAnimation(parent: _controller,
      curve: Curves.easeInOut),
  );
}
```

5. Inside the button's onPressed handler, call _controller.forward() to start the animation.

```
FloatingActionButton(
  onPressed: () => _controller.forward(),
  child: const Icon(Icons.play_arrow),
),
```

Introduction to Flutter Package

Package is a library that contains special functions, classes or codes that can be used repeatedly. In flutter we get this package or library on the official flutter pub.dev website. In general, a Dart package is the same as a Dart application. But the Dart package does not have an application entry point which is the main function.

The general structure of package (example : demo package, my_demo_package) is as below :

- lib/src/* : private Dart code files.
- lib/my_demo_package.dart : main Dart code file. It can be imported into an application as :

```
import 'package:my_demo_package/my_demo_package.dart'
```

- Other private code file may be exported into main code file (my_demo_package.dart), if necessary as shown below :

```
export src/my_private_code.dart
```

- lib/* : any number of Dart code files arranged in any custom folder structure. The code can be accessed as :

```
import 'package:my_demo_package/custom_folder/custom_file.dart'
```

- pubspec.yaml : project specification, same as that of application.

The Difference Between A Package & A Plugin

A plugin is a type of package, meaning the full designation is plugin package, which is generally shortened to plugin.

Packages : at a minimum, a Dart package is a directory containing a pubspec.yaml file. Additionally, a package can contain dependencies (listed in the pubspec), Dart libraries, apps, resources, tests, images, fonts, and examples.

Plugins : a plugin package is a special kind of package that makes platform functionality available to the app. Plugin packages can be written for Android (using Kotlin or Java), iOS (using Swift or Objective-C), web, macOS, Windows, Linux, or any combination thereof.

Using Packages

1. Search for packages. Packages are published to pub.dev. Can also browse the packages on pub.dev by filtering on Android, iOS, web, Linux, Windows, macOS, or any combination thereof.
2. Adding package using :
   For example add the package, css_colors, to an app :
   - Adding a package dependency to an app

a. Open the pubspec.yaml file located inside the app folder, and add css_colors: under dependencies.
b. Install it
    - From the terminal: Run flutter pub get.
    - From VS Code: Click Get Packages located in the right side of the action ribbon at the top of pubspec.yaml indicated by the Download icon.
    - From Android Studio/IntelliJ: Click Pub get in the action ribbon at the top of pubspec.yaml.
c. Add a corresponding import statement in the Dart code.

- Adding a package dependency to an app using command prompt :
    a. Issue the command while being inside the project directory.

```
flutter pub add css_colors
```

    b. Add a corresponding import statement in the Dart code.

3. If want to remove a package dependency to an app can using command prompt for example remove the package, css_colors, to an app with issue the command while being inside the project directory.

```
flutter pub remove css_colors
```

Introduction to Flutter Local Data Persistence

Local data persistence is the process of storing data on a local device, such as a phone or tablet. This data will remain on the device even after the app is closed or the device is restarted. It is important for mobile apps because it allows apps to store user data, such as settings, login data, or game data. This data can be accessed again by the app at any time, even when the device is not connected to the internet. Flutter offers various methods to perform local data persistence, such as:

- Key-value storage
- File storage
- Database

Key-value storage

Key-value storage is the simplest method of storing data. Data is stored in the form of key-value pairs, where the key is a string and the value can be any data type.

SharedPreferences

Flutter provides the SharedPreferences class to perform key-value storage. It is usually used by developers to store login tokens or store application settings. SharedPreferences has several parameters, which are :

- key : unique identification for the data being stored or retrieved.
- value : value to be saved to SharedPreferences.
- type : data type of the value to be saved or retrieved.

SharedPreferences provides various methods to store and retrieve data from local devices. Some commonly used methods include :

- getBool(key) : returns a boolean value with the specified key. Returns null if the key is not found.
- setBool(key, value) : stores a boolean value with the specified key.
- getInt(key) : returns an integer value with the specified key. Returns null if key is not found.
- setInt(key, value) : stores an integer value with the specified key.
- getString(key) : returns a string value with the specified key. Returns null if the key is not found.
- setString(key, value) : stores a string value with the specified key.

Other than these methods, SharedPreferences also provides other methods to store and retrieve data with other data types, such as :

- getDouble(key) : returns a double value with the specified key.
- setDouble(key, value) : stores a double value with the specified key.
- getFloat(key) : returns the float value with the specified key.
- setFloat(key, value) : stores a float value with the specified key.
- getList(key, type) : returns a list of data with the specified data type. Returns null if the key is not found.
- setList(key, value, type) : stores a list of data with the specified data type.

Step-by-step for setting up the flutter SharedPreferences :

1. Create a SharedPreferences object and obtain a SharedPreferences instance

```
prefs = await SharedPreferences.getInstance()
```

2. Reads and stores the value. This is exemplified using bool.

```
//store value
prefs.setBool("darkMode", true)
//read boolean value with key "darkMode", return null if key
didn't found
prefs.getBool("darkMode")
```

3. Then update the ui state.

File storage

File storage is a more complex data storage method than key-value storage. Data is stored in the form of files, which can be text files, binary files, or other format files.

File Class

Flutter provides the File class to perform file storage. This class is in library dart:io which is the class to represent a file on the device's file system. This class provides methods for reading, writing, deleting, and managing files. To use this class, must import the dart:io library. Its key methods :

- readAsBytes() : reads the file's contents as a list of bytes.
- readAsString([encoding]) : reads the file's contents as a string, optionally specifying the encoding.
- writeAsBytes(List<int> bytes, [mode]) : writes a list of bytes to the file, with an optional mode (write, append).
- writeAsString(String contents, [encoding, mode]) : writes a string to the file, optionally specifying encoding and mode.
- exists() : returns true if the file exists, false otherwise.
- delete() : deletes the file.
- length() : returns the size of the file in bytes.
- lastModified() : returns the last modification timestamp of the file.
- path : the file's path on the filesystem.
- parent : the parent directory of the file.

Then there are a few things to keep in mind and be extra when using it :

- **Asynchronous Operations :** most file operations are asynchronous, so use the asynchronous and wait keywords to handle them correctly.
- **FileMode :** determines how to open a file when using readAsBytes or writeAsString. Commonly used modes are read, write (overwrite), and append.
- **Error Handling :** consider using a try-catch block to handle potential errors during file operations.
- **Permissions :** make sure the app has the necessary permissions to access files on the device, especially for Android and iOS.
- **Path Provider Package :** use this package for platform-specific paths to common directories (documents, downloads, etc.).
- **Non-Web Platforms :** the dart:io library is primarily for non-web platforms (mobile, desktop, server). For web-based file handling, consider using the dart:html library or a browser-specific API.

```
import 'dart:io';
```

```
//creating file object
File file = File('path/to/your/file.txt');
//using FileMode
await file.writeAsString('Hello, world!', mode:
FileMode.write);
```

Path and PathProvider

Path provides access to the device's file system, while PathProvider provides a way to get Path instances for various locations on the device. Path and PathProvider can be used to store data in files on the device. For example, you can use Path to create a new file, write data to a file, or read data from a file. You can also use PathProvider to get Path instances for specific directories on the device, such as internal storage directories or external storage directories. Path and PathProvider support file system based persistence in a way :

- Path : Provides an API for accessing and manipulating files and directories on the device's file system.
- PathProvider : Helps find secure application- and system-specific directories for storing persistent data.

Therefore, while Path and PathProvider do not directly perform persistent data storage, they are important tools that are required and often used in conjunction with other persistent data storage methods such as SharedPreferences, SQLite, or local files with specific formats.

To illustrate, Path and PathProvider can be compared to a house :

- The house (persistent data) would not stand on its own without the foundation and frame (storage method).
- Paths and PathProviders are like construction materials and tools (helpers) needed to build that foundation and frame, so that the house (persistent data) can stand firmly and not be easily erased.

Path package also provides various other methods to access and manipulate the file system. Here are some of these methods :

- dirname() : returns the parent directory path of the given path.
- join() : returns a file that merges two paths into one path.
- basename() : returns the filename of the given path.
- extension() : returns the file extension of the given path.
- normalize() : returns the normalized path.
- canonicalize() : returns the canonicalized path.
- split() : splits the path into parent directory and file name.
- segments() : returns a list of segments from the path.
- isAbsolute() : returns true if the path is absolute, false otherwise.
- isRelative() : returns true if the path is relative, false otherwise.

- operator ==() : compares two paths.
- operator !=() : compares two paths.

The use of these two packages:

```
import 'dart:io';
import 'package:path/path.dart' as path;
import 'package:path_provider/path_provider.dart';

void main() async {
  // Get the Path instance for the internal storage directory
  final internalStorageDirectory = await
getApplicationDocumentsDirectory();

  // Create a merge path
  final path = path.join(internalStorageDirectory.path,
'my_file.txt');

  // Create a new file
  final file = File(path);

  // Write data to file
  file.writeAsString('This is the data');

  // Read data from file
  final data = file.readAsString();
  print(data);
}
```

Database

Databases are the most complex and flexible data storage method. Data is stored in the form of tables, which can be connected to each other. Flutter provides various database plugins, such as sqflite, moor, and objectbox. These plugins provide APIs for creating and managing databases. Moreover, here is the basic concept of a local database using sqflite.

Sqflite

sqflite package is one of the flutter packages that provides an interface to the SQLite database, a lightweight and widely used database engine embedded in most mobile operating systems. Because sqflite has a relationship with SQLite database, it will be explained first about SQLite. SQLite is a lightweight and portable relational database management system (RDBMS) designed for use in applications running on a single device. SQLite is an in-memory database, which means that data is stored in the device's main memory. This makes it ideal for applications that require quick access to data, such as mobile applications. SQLite is a relational database, which means that data is stored in tables consisting of rows and columns. Each row represents one record, and each column represents one attribute of that record. SQLite provides various standard RDBMS features, such as:

- CREATE TABLE : Creates a new table.
- INSERT INTO : Adds new data to a table.

- SELECT : Retrieves data from a table.
- UPDATE : Changes the data in the table.
- DELETE : Deletes data from a table.

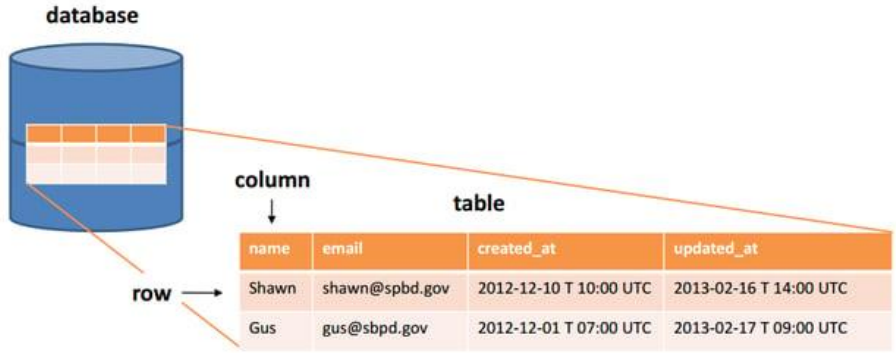
SQLite also provides some additional features, such as :

- TRIGGER : Events that occur when certain operations are performed on a table.
- VIEW : The virtual table represented by the query.
- INDEX : A data structure that improves query performance.

That is why sqflite provides access to connect the interface with the database.

Key concepts used in the sqflite package are as follows:

- Database : A collection of organized data stored on the device.
- Tables : Structures within a database that hold related data in rows and columns.
- Columns : Represent a specific attribute of the data, having a name and a data type.
- Rows : Individual records within a table, each containing values for the table's columns.



Step-by-step for setting up and using the flutter sqflite :

1. Import the package

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

2. Open a database with database instance

```
// Get a database instance
Database db = await openDatabase('my_database.db');
```

3. Create tables

```
await db.execute('''
  CREATE TABLE IF NOT EXISTS tasks (
    id INTEGER PRIMARY KEY AUTOINCREMENT,
    title TEXT,
    description TEXT,
    completed INTEGER
  )
''');
```

4. Insert data, important parameters in the insert method are the table name, and the data type of Map that want to insert.

```
await db.insert('tasks', {
  'title': 'Task 1',
  'description': 'Description of Task 1',
  'completed': 0
});
```

5. Query/Read data, usually will be stored at List<Map<T,T>> because the data we will get is data of type Map.

```
List<Map<String, dynamic>> tasks = await db.query('tasks');
```

6. Update data, important parameters in the update method are the table name, one of the data requirements with map data type, where the data is stored, and provide a query as the argument (the primary key).

```
await db.update('tasks', {'completed': 1}, where: 'id = ?',
whereArgs: [id]);
```

7. Delete/Remove data, important parameters in the delete method are the table name, where the data is stored, and provide a query as the argument (the primary key).

```
await db.delete('tasks', where: 'id = ?', whereArgs: [id]);
```

8. Close the database

```
await db.close();
```

Usually sqflite package use asynchronous operations await when working and also handle potential errors with try-catch blocks.

Introduction to Flutter Media

Flutter Media is a collection of classes, functions and APIs that allow you to play, record, and manipulate media in your Flutter app. Media is a critical component of many mobile apps, and Flutter Media provides a comprehensive and easy-to-use set of tools for working with media. Flutter Media supports a variety of media types, including video, audio, images, and text.

Image Picker

Package flutter image_picker is a package that allows you to capture images from the camera or select images from the device gallery. This plugin supports a variety of image types, including photos, images, and GIFs. To retrieve an image from the gallery, you can use the pickImage method. Its key parameters :

- source : source of the image, which can be ImageSource.gallery or ImageSource.camera.
- maxWidth : maximum width of the image, in pixels.
- maxHeight : maximum height of the image, in pixels.

- imageQuality : quality of the image, in percentage.

This can be stored in the File class as described earlier. Then when the image is selected, do not forget to create a File object from the image path and update the state using setState(). Therefore, we recommend using a Stateful Widget. Also if you want to display with an image widget, it is better to use the file constructor (image.file).

```
File? image;

Future pickImage() async {
  final pickedFile = await ImagePicker().pickImage(source:
ImageSource.gallery);
  if (pickedFile != null) {
    setState(() {
      image = File(pickedFile.path);
    });
  }
}
```

File Picker

Package flutter file_picker is a package that allows you to select files from the device. It supports a variety of file types, including documents, images, and videos. To select files, you can use the pickFiles method. Its key parameters :

- source: source of the file, which can be FileType.any (all file types), FileType.image (only images), FileType.video (only videos), or FileType.custom (a specific file type).
- allowedExtensions: list of allowed file extensions.
- maxFiles: maximum number of files that can be selected.

```
FloatingActionButton(
  onPressed: () async {
    final result = await FilePicker.platform.pickFiles();
     if(result == null) return;
    setState(() {
      //...
    });
  }
)
```

Here are some additional features of the flutter file_picker package:

- Supports file selection from cloud storage, such as Google Drive and Dropbox.
- Supports file selection from other devices, such as devices connected via USB.
- Supports file selection from the web, such as files hosted on the server.

Camera

Flutter already provides a package for iOS, Android, and Web that allows access to the device's camera, which is named the camera package. This package provides tools to get a

list of available cameras, show previews from specific cameras, and take photos or videos. There are camera package features :

- Display live camera preview in a widget.
- Snapshots can be captured and saved to a file.
- Record video.
- Add access to the image stream from Dart.

To be able use this package, the main requirement is to add configuration permissions, especially on Android and iOS. For Android, you need to change the minimum Android SDK version to 21 or more in android/app/build.gradle, while iOS needs version 10 or more in ios/Runner/Info.plist. There are several methods, properties, and parameters required in the camera package. The most commonly used ones are as follows :

- Method :
    - availableCameras() : Gets the list of cameras available on the device.
    - initialize() : Initializes the camera.
    - takePicture() : Takes a picture.
    - startVideoRecording() : Starts video recording.
    - stopVideoRecording() : Stops video recording.
- Properties :
    - Value : This property contains information about the status of the camera, such as whether the camera has been initialized, whether the camera is in use, and so on. This property has several getters, including :
        - isInitialized : This getter returns a boolean value indicating whether the camera is initialized.
        - isRecordingVideo : This getter returns a boolean value indicating whether the camera is recording video.
    - isRecordingVideo : This property contains information about whether the camera is recording video.
- Parameters :
    - ResolutionPreset : This parameter is used to set the resolution of the camera. This parameter has several values that can be used, including :
        - low : Low resolution (240p)
        - medium : Medium resolution (720p)
        - high : High resolution (1080p)
        - max : The highest resolution supported by the camera
    - FlashMode : This parameter is used to set the flash mode. This parameter has several values that can be used, including :
        - off : Flash off

- auto : Flash automatically
- always : Flash always on
- torch : Flash on constantly

To use the package, there are steps that need to be followed.

1. Get the camera list in the main function.
    - WidgetsFlutterBinding.ensureInitialized(); : Ensures the Flutter engine is initialized before accessing the cameras.
    - final cameras = await availableCameras(); : Gets the list of cameras available on the device.
    - final firstcam = cameras.first; : Retrieves the first camera as the default camera.

```
Future<void> main() async {
  WidgetsFlutterBinding.ensureInitialized();
  final cameras = await availableCameras();
  final firstcam = cameras.first;
  runApp( /*...*/ );
}
```

2. To use the camera, create a Stateful Widget. Then create some objects.
    - _controller : CameraController object to control the camera.
    - _initialControllerFuture : Future for the camera initialization process.
    - url : String to store the path of the captured image.
    - isCameraSwitch : Boolean to determine which camera is being used.

```
class MyApp extends StatefulWidget {
  @override
  _MyAppState createState() => _MyAppState();
}

class _MyAppState extends State<MyApp> {
  late CameraController _controller;
  late Future<void> _initialControllerFuture;
  String url = "";
  bool isCameraSwitch = true;
  //Fill the code
}
```

3. Fill initState.
    - Initializes _controller with the selected camera.
    - Starts the camera initialization process with _controller.initialize().

```
@override
void initState() {
  super.initState();
  _controller = CameraController(widget.camera,
ResolutionPreset.max);
  _initialControllerFuture = _controller.initialize();
}
```

4. If you want to give control to switch cameras, you need to create 2 functions for that :
    - The first function is filled with
        - Switches the camera used by _controller.
        - Initializes the newly selected camera again.

```
void _switchCamera() {
  setState(() {
    isCameraSwitch = !isCameraSwitch;
    _controller = CameraController(
      isCameraSwitch ? widget.camera :
_getOtherCamera(),
      ResolutionPreset.max,
    )..initialize().then((_) => setState(() {}));
  });
}
```

    - The second function is to restore a camera that is not the currently active camera (to switch cameras).

```
CameraDescription _getOtherCamera() {
  return widget.camera ==  widget.listcam.first
      ? widget.listcam.last
      : widget.listcam.first;
}
```

5. To take a picture it is necessary to add :
    - The picture taking button calls _controller.takePicture().
    - The path of the captured image is stored in the url variable.

```
IconButton(
  icon: const Icon(Icons.camera, color: Colors.white),
  onPressed: () async {
    await _initialControllerFuture;
    final image = await _controller.takePicture();
    setState(() => url = image.path);
  },
)
```

6. To display the preview camera, you need to add the CameraPreview widget(_controller).

```
AspectRatio(
  aspectRatio: _controller.value.aspectRatio,
  child: CameraPreview(_controller),
)
```

7. To activate the flash, you need to call _controller.setFlashMode(FlashMode.torch).

```
IconButton(
  icon: const Icon(Icons.flash_on),
  onPressed: () {_controller.setFlashMode(FlashMode.torch);},
)
```

Video Player

Package flutter video_player is a package that allows you to play videos in the Flutter app. This plugin supports various types of videos, including local videos, videos from the internet, and videos from the camera. To play videos, you can use the VideoPlayer class. Its key properties :

- controller : video controller used to control video playback.
- autoplay : whether the video will play automatically when the application starts.
- looping : whether the video will be played repeatedly.
- onPlayerInitialized : function that is called when the video is initialized.
- onPlayerError : function that is called when an error occurs while playing the video.
- onPlayerCompletion : function that is called when the video is finished playing.

VideoPlayerController is used to control video playback. You can initialize the VideoPlayerController by using the asset(), file(), network(), or camera() methods.

To play a video, you can use the VideoPlayer class. This class has several methods, including:

- setSource(String path) : sets the video source, which can be the path to a video file or a URL to an online video.
- play() : starts video playback.
- pause() : pauses video playback.
- stop() : stops video playback.

On initState :

1. Create a VideoPlayerController object.
2. Call the setSource() method on the VideoPlayerController object to set the video source.
3. Call the addListener() method of the VideoPlayerController object to keep listening to the video multiple times.
4. Call the initialize() method of the VideoPlayerController object asynchronously to initialize video playback.
5. Use setState() to update the UI after the video playback is initialized.

On aspectRatio :

1. Use the value property of the VideoPlayerController object to get information about the aspect ratio of the video.
2. Use the aspectRatio property of the AspectRatio widget to set the aspect ratio of the video player.

Step-by-step for setting up and using the flutter video_player package :

1. Import the video_player library into your code.

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

2. Create a VideoPlayerController object.
3. Call the setSource() method on the VideoPlayerController object to set the video source.
4. Call the initialize() method of the VideoPlayerController object to initialize video playback.

```
VideoPlayerController _controller;

@override
void initState() {
  super.initState();
  _controller =
VideoPlayerController.asset('assets/video.mp4');
  _controller.addListener(() {
    setState(() {});
  });
  _controller.initialize().then((_) {
    setState(() {});
  });
}
```

5. Use the value property of the VideoPlayerController object to get information about the video status.

```
Center(
  child: _controller.value.isInitialized
      ? AspectRatio(
          aspectRatio: _controller.value.aspectRatio,
          child: VideoPlayer(_controller),
        )
      : Container(),
)
```

6. Use the play(), pause(), or stop() methods of the VideoPlayerController object to manipulate video playback.

```
FloatingActionButton(
  onPressed: () {
    _controller.play();
  },
  child: Icon(Icons.play_arrow),
)
```

Audio Player

Flutter audioplayer package is a package that allows you to play audio in the Flutter app. This plugin supports various types of audio formats, including MP3, WAV, and AAC. To play audio, you can use the AudioPlayer class. This class has several methods, including:

- UrlSource(String url) : sets the URL of the audio to be played.
- play() : starts audio playback.
- pause() : pause audio playback.

- stop() : stops audio playback.

In addition, the AudioPlayer class also has several properties, including :

- isPlaying: contains information about whether the audio is playing or not.
- duration: contains the duration of the audio in seconds.
- position : contains the current position in the audio in seconds.

Step-by-step for setting up and using the flutter audioplayer package :

1. Import the audioplayer library into your code.

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

2. Create an AudioPlayer object.

```
final player = AudioPlayer();
```

3. Use the play() methods of the AudioPlayer object to play the audio, but parameters inside play() method must be filled with UrlSource() to set url audio. .
4. Also use other methods, for example pause() and stop() method of the AudioPlayer object to manipulate video playback.

```
IconButton (
  icon: Icon (
    Icons.play_arrow, color: Colors.black
  ),
  onPressed: () {
    isPlaying ? player.pause()
      : player.play(UrlSource("assets/audio/audio.mp3"));
  }
)
```