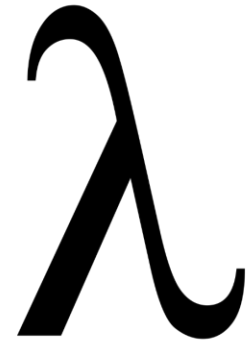




# Dart

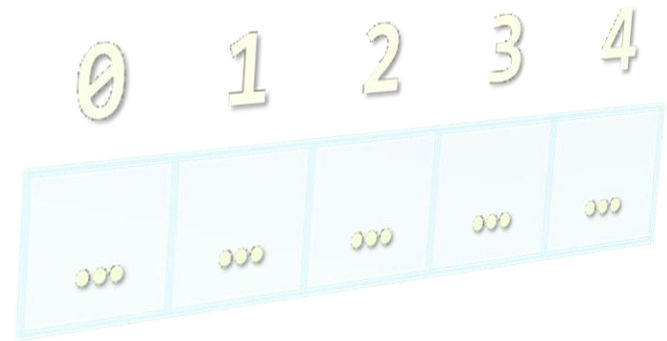
**Functional Programming**



# Table of Contents

1. Collections
2. Lambda
3. Common operations on collections
4. Records
5. Json
6. Pattern Matching

# Collections



# List

- Dart has a `List<T>` type to declare list

```
List<String> colors = ["Red", "Green", "Blue"];
```

```
var names = ["Ali", "Ahmed", "Sara"];
```

```
const nums = [2, 3, 4];
```

```
var nullNums = List<int?>.filled(10, null);
```

```
colors.forEach((color) => print(color));
```

```
names.forEach((name) => print(name));
```

```
nums.forEach((num) => print(num));
```

```
nullNums.forEach((num) => print(num));
```

# List Methods

```
const nums = [2, 3, 4];  
  
nums.add(8);  
nums.insert(0, 1);  
nums.removeAt(2);  
nums.remove(4);  
nums.removeLast();  
nums.removeRange(0, 2);  
nums.removeWhere((num) => num > 3);  
nums.removeRange(0, nums.length);  
nums.addAll([1, 2, 3]);  
nums.addAll([4, 5, 6]);
```

# List destructuring

- List destructuring allows you to unpack or extract values from a list and assign them to variables in a clean and concise way

```
var fruits = ["Apple", "Banana", "Cherry", "Mango", "Orange"];

// Destructuring the list
// ... is used to unpack the remaining elements
var [firstFruit, secondFruit, thirdFruit, ...others] = fruits;

print("First fruit: $firstFruit");    // Output: First fruit: Apple
print("Second fruit: $secondFruit"); // Output: Second fruit: Banana
print("Third fruit: $thirdFruit");   // Output: Third fruit: Cherry
print("Others: $others");            // Output: Others: [Mango, Orange]
```

# Spread operator (...)

- Spread operator (...) allows you to include all elements of one list inside another list
  - It "spreads" the elements of a list into a new list
  - The null-aware spread operator (...?) is used when the list you're spreading might be null

```
List<String> fruits = ["Apple", "Banana"];
```

```
List<String> vegetables = ["Carrot", "Broccoli"];
```

```
List<String> food = fruits + vegetables;
```

```
print(food); // Output: [Apple, Banana, Carrot, Broccoli]
```

```
food = [...fruits, ...vegetables];
```

```
print(food); // Output: [Apple, Banana, Carrot, Broccoli]
```

# Set

- *Set is same as List but does not allow duplicates*

```
final Set<String> colors = {"red", "blue", "yellow"};
colors.add("pink"); // Adding a new element
// Won't be added again because sets don't allow duplicates
colors.add("blue");
print(colors); // Output: {red, blue, yellow, pink}
```



# Map

- Stores keys and associated values

```
Map<int, String> languages = {  
    1: "Python",  
    2: "Kotlin",  
    3: "Java",  
};
```

```
languages.forEach((key, value) {  
    print("$key => $value");  
});
```

# Lambda

A large, stylized black lambda symbol ( $\lambda$ ) is centered on the page. The symbol is a cursive-style character with a thick stroke, featuring a small hook at the top and a curved tail at the bottom.

# Imperative vs. Declarative

## Imperative Programming

- You tell the computer **how** to perform a task

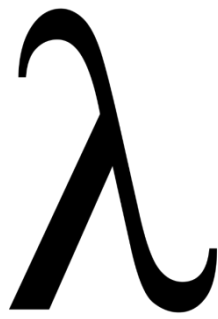
## Declarative Programming

- You tell the computer **what you want**, and you let the compiler (or runtime) figure out the best way to do it. This makes the code simpler and more concise
- Also known as **Functional Programming**
- **Declarative programming using Lambdas helps us to achieve KISS**

**K**EEP **I**T **S**HORT & **S**IMPLE



# What is a Lambda?



- Lambda is an **anonymous function** that you can store in a variable, pass them as parameter, or return from other function. It has:
  - Parameters
  - A body
- It **don't have a name** (anonymous method)
- It **can be passed as a parameter** to other function:
  - As *code* to be executed by the receiving function
- Concise syntax:

**(Parameters)  $\Rightarrow$  Body**

# Passing Lambda as a Parameter

- Lambda expression can be passed as a parameter to methods such as *forEach*, *filter* and *map* methods :

```
var numbers = [1, 2, 3, 4, 5, 6, 7, 8, 9];  
numbers.forEach((e) => print(e));
```



**forEach** - Calls a Lambda on Each Element of the list

- Left side of **=>** operator is a parameter variable
- Right side is the code to operate on the parameter and compute a result
- When using a lambda with a List the compiler can determine the parameter type

# Lambda usage

- Allows working with collections in a **functional style**

```
bool isEven(int n) => n % 2 == 0;
void main() {
    // Range (1 to 10 inclusive)
    List<int> nums = List.generate(10, (i) => i + 1);
    // Version 1
    bool hasEvenNumber = nums.any((n) => n.isEven);
    // Version 2
    hasEvenNumber = nums.any(isEven);

    // Version 3 - most compact
    hasEvenNumber = nums.any((n) => n % 2 == 0);
    print("Has even number: $hasEvenNumber");

    // Version 1
    List<int> evens = nums.where(isEven).toList();

    // Version 2
    evens = nums.where((n) => n % 2 == 0).toList();

    print("Even numbers: $evens");
}
```

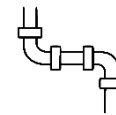
# Lambda usage

e.g. What's the average age of employees working in Doha?

```
List<Employee> employees = [  
    Employee(name: "Sara Faleh", city: "Doha", age: 30),  
    Employee(name: "Mariam Saleh", city: "Istanbul", age: 22),  
    Employee(name: "Ali Al-Ali", city: "Doha", age: 24),  
];  
  
// Filtering employees in "Doha", mapping their ages,  
// and calculating the average  
double avgAge = employees  
    .where((employee) => employee.city == "Doha")  
    .map((employee) => employee.age)  
    .reduce((a, b) => a + b) /  
    employees.where((employee) => employee.city == "Doha").length;  
  
print("Average age of employees in Doha: $avgAge");
```

# Common operations on collections

**Filter, Map, Reduce, and others**







# Common operations on collections

**.map** 

- Applies a function to each list element

**.where(condition)** 

- Returns a new list with the elements that satisfy the condition

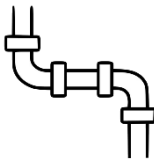
**.firstWhere(cond:  on)**

- Returns the first list element that satisfy the condition

**.reduce** 

- Applies an accumulator function to each element of the list to reduce them to a single value

# Operations Pipeline

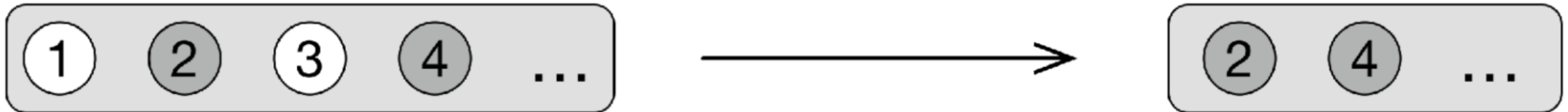


- **A pipeline of operations:** a sequence of operations where the output of each operation becomes the input into the next
  - e.g., `.where -> .map -> .toList`
- Operations are either **Intermediate** or **Terminal**
- **Intermediate operations** produce a new list as output (e.g., `map`, `filter`, ...)
- **Terminal operations** are the final operation in the pipeline (e.g., `find`, `reduce`, `toList` ...)
  - Once a terminal operation is invoked then no further operations can be performed

# Filter using `.where`

Keep elements that satisfy a condition

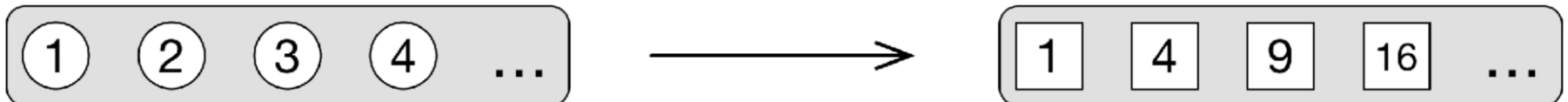
```
nums.where((n) => n % 2 == 0)
```



## Map

Transform elements by applying a Lambda to each element

```
nums.map((n) => n * n)
```



# Reduce



Apply an accumulator function to each element of the list to reduce them to a single value

*// Imperative*

```
var sum = 0;  
for (var n in list)  
    sum = sum + n;
```

*//Declarative*

```
var sum = nums.reduce( (acc, n) => acc + n );
```

Accumulation  
Variable

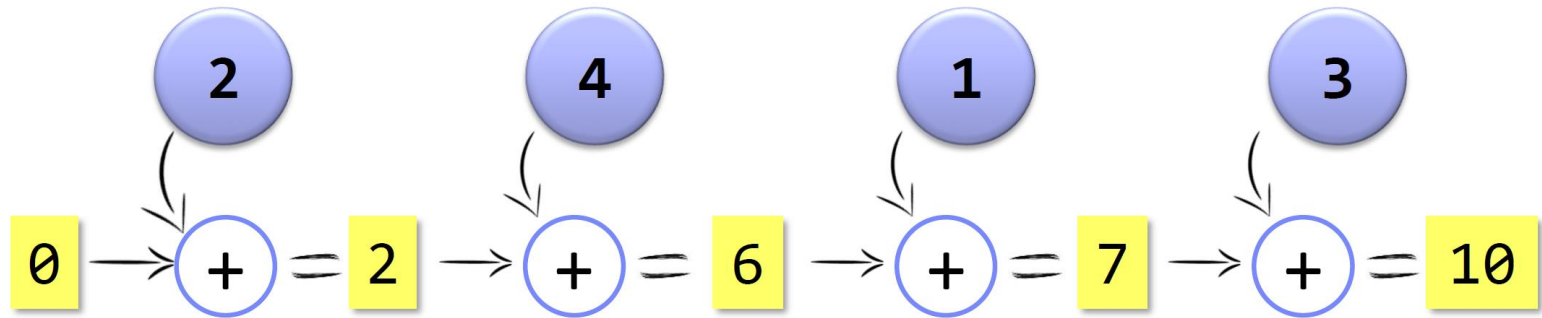
Accumulation  
Lambda

Collapse the multiple elements of a list into a single element



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# Reduce



*.reduce* { (acc, n) => acc + n }

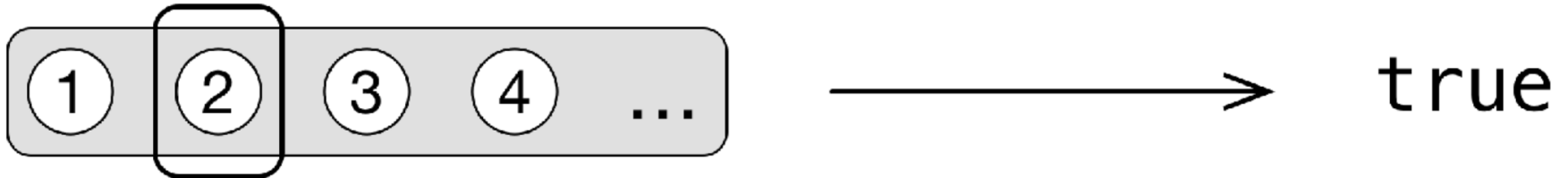
Reduce is **terminal** operation that yields a single value

# any and every



- **any** returns true if it finds an element that satisfies the lambda condition
- **every** returns false if it finds an element that fails the lambda condition

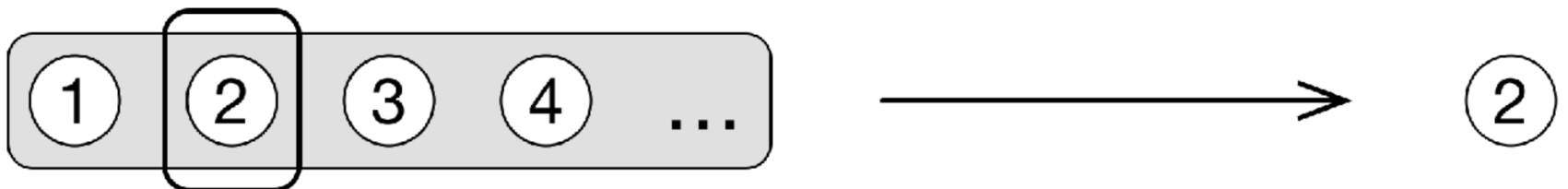
```
var hasEvenNumber = nums.any((n) => n % 2 == 0);
```



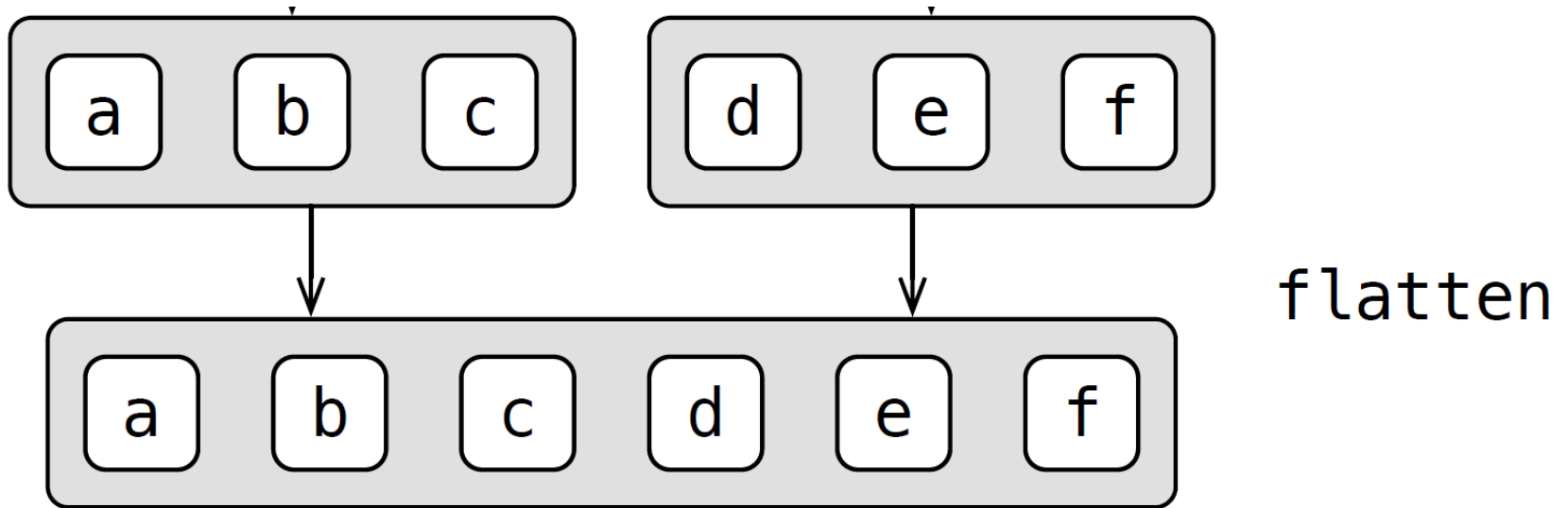
## firstWhere

Return first element satisfying a condition

```
var firstEven = nums.firstWhere((n) => n % 2 == 0);
```



# Expand



```
List<List<String>> listOfList = [  
    ["a", "b", "c"],  
    ["d", "e", "f"]  
];
```

```
// Flattening the list of lists
```

```
List<String> singleList = listOfList.expand((list) => list).toList();
```

```
// Printing the result
```

```
print(singleList); // Output: [a, b, c, d, e, f]
```

# expand

Do a map and flatten the results into 1 list

Each book has a list of authors. **expand** combines them to produce a single list of **all** authors

```
List<Book> books = [  
    Book("Head First Dart", ["Dawn Griffiths", "David Griffiths"]),  
    Book("Dart in Action", ["Dmitry Jemerov", "Svetlana Isakova"]),  
];  
  
// Flattening the list of authors  
var authors = books.expand((book) => book.authors);  
print(authors);
```



# Sort a List using Lambda

Sort strings by length (shortest to longest)

```
List<String> names = ["Farid", "Saleh", "Ali", "Sarah", "Samira",  
"Farida"];
```

```
var sorted = List.of(names)..sort((a, b) =>  
    a.length.compareTo(b.length));
```

```
// Without the cascade operator, you would have to  
// do this in two steps:
```

```
// sorted = List.of(names);  
// sorted.sort((a, b) => a.length.compareTo(b.length));
```

```
print(names);
```

```
print(">Sorted by length:");  
print(sorted);
```

# Record

- Records is a data structure that allows you to group **multiple values together** (with parentheses) without needing to create a class
  - useful when you need to return or pass around multiple values from a function or when you want to combine values into a logical unit without a class
  - Supports Positional and Named Fields: Records can have both positional and named fields
  - Type Safety: Dart records are strongly typed, meaning the fields have specific types that must be followed
  - Immutability: Records are immutable; once created, you cannot change the values in them

# Why Use Records?

- Convenient for returning multiple values:
  - Records are simpler than creating custom classes
  - No need for classes: You don't need to define a separate class for temporary or simple structures
- Type Safety: You have clear type constraints, reducing errors
- Readable code: Named fields improve readability and allow for clearer intent without the need for complex structures
- Efficient: Records are lightweight and immutable

# Record Example

```
// Function returning coordinates as a record
(double, double) getCoordinates() {
    double latitude = 25.276987;
    double longitude = 51.520008;
    return (latitude, longitude); // Return a record with two
positional fields
}

void main() {
    var coordinates = getCoordinates();

    print("Latitude: ${coordinates.$1}");
    print("Latitude: ${coordinates.$2}");

    // Extract the latitude and longitude from the record
    var (latitude, longitude) = getCoordinates();
    print("Latitude: $latitude");
    print("Longitude: $longitude");
}
```

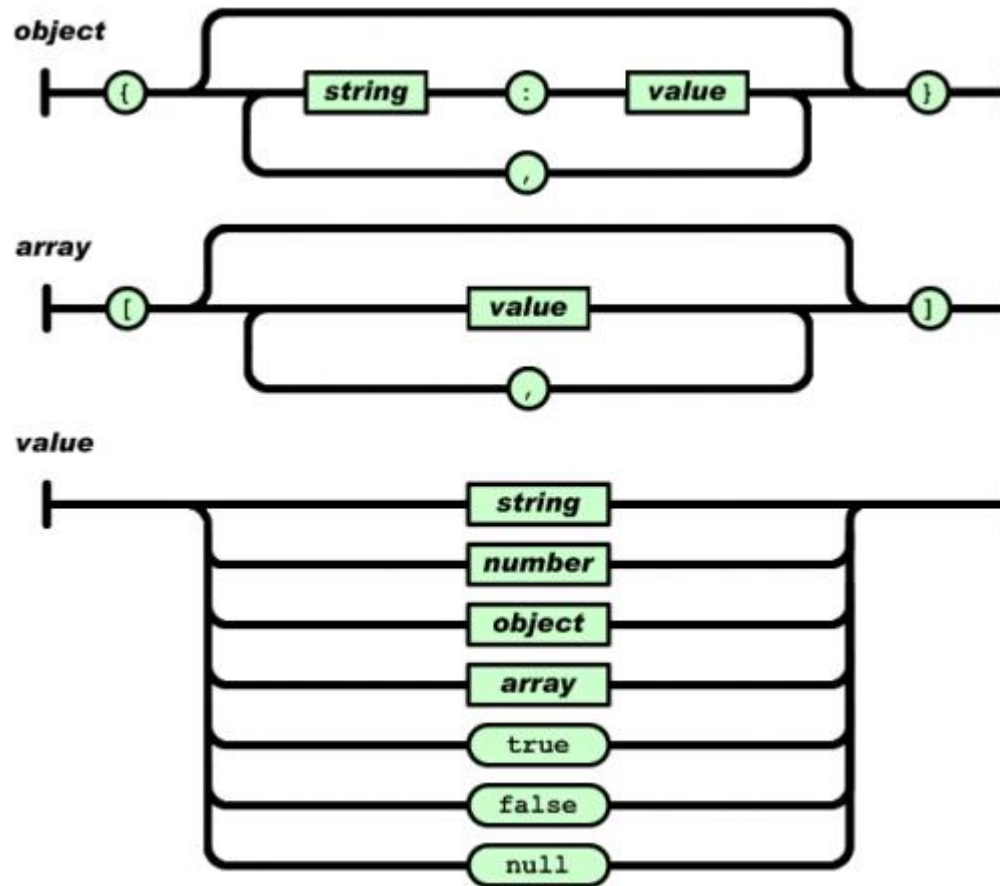
# Record with named fields

- Makes the code more readable and self-explanatory:  
Named fields make it clear what each value represents

```
// Function returning coordinates as a record with named fields
({double lat, double lon}) getCoordinates() {
    double latitude = 25.276987;
    double longitude = 51.520008;
    // Return a record with named fields
    return (lat: latitude, lon: longitude);
}

void main() {
    var coordinates = getCoordinates();

    // Extract the latitude and longitude from the record
    print("Latitude: ${coordinates.lat}");
    print("Longitude: ${coordinates.lon}");
}
```



# JSON Data Format

- **JSON** (JavaScript Object Notation) is a very popular **lightweight data format** to transform an object to a **text** form to ease storing and transporting data
  - Encoding (aka serialization) turning a data structure into a string
  - Decoding (aka deserialization) is the opposite process  
-> turning a string into a data structure

# Serializing JSON manually using **dart:convert**

- Flutter has a built-in **dart:convert** library that includes a straightforward JSON encoder and decoder

```
import 'dart:convert';

void main() {
  var jsonString = '''
    {
      "name": "John Smith",
      "email": "john@dart.dev"
    }''';

  // Parse the JSON string into a Map
  final user = jsonDecode(jsonString) as Map<String, dynamic>;

  print('Hello, ${user['name']}!');
  print('We sent the verification link to ${user['email']}.');

  final userJsonString = jsonEncode(user);
  print(userJsonString);
}
```



# Serializing JSON inside model classes

- Add two methods to the class:
  - A `Surah.fromJson()` constructor, for constructing a new `Surah` instance from a map structure
  - A `toJson()` method, which converts a `Surah` instance into a map

```
// Convert a Surah object to a JSON map
Map<String, dynamic> toJson() => {
  'number': number,
  'arabicName': arabicName,
  'englishName': englishName,
  'verseCount': verseCount,
  'type': type,
};
```

```
// Convert a JSON map to a Surah object
Surah.fromJson(Map<String, dynamic> json) :
  number = json['number'],
  arabicName = json['arabicName'],
  englishName = json['englishName'],
  verseCount = json['verseCount'],
  type = json['type'];
```

## Surah

- id: int
- name: String
- englishName: String
- ayaCount: int
- type: String

# Serializing JSON using a code generation library

- Package [json\\_serializable](#) can be used to auto-generate the implementation of `fromJson` and `toJson`
  - Simply annotate the class with **@JsonSerializable()**

```
/// An annotation for the code generator to know that this class needs the
/// JSON serialization logic to be generated.
@JsonSerializable()
class User {
  String name;
  String email;
  User(this.name, this.email);

  /// A necessary factory constructor for creating a new User instance
  /// from a map. Pass the map to the generated `_$UserFromJson()` constructor.
  /// The constructor is named after the source class, in this case, User.
  factory User.fromJson(Map<String, dynamic> json) => _$UserFromJson(json);

  /// `toJson` implementation simply calls the private, generated
  /// helper method `_$UserToJson`.
  Map<String, dynamic> toJson() => _$UserToJson(this);
}
```

# json\_serializable dependencies

- To utilize [json\\_serializable](#) package, ensure that you include the required dependencies in **pubspec.yaml**

```
dev_dependencies:  
  build_runner: ^2.4.9  
  json_annotation: ^4.9.0  
  json_serializable: ^6.8.0
```

- Run the build\_runner to generate the .g.dart files:

```
dart run build_runner build --delete-conflicting-outputs
```

# Read JSON file

- Read a JSON file and convert its content to objects

```
final filePath = "data/surahs.json"  
// Read the content of the file at the given path as a string  
final fileContent = File(filePath).readAsStringSync();  
  
// Parse the JSON content into a list of dynamic objects  
final List<dynamic> jsonList = jsonDecode(fileContent);  
  
// Convert each dynamic object into a Surah instance using fromJson  
final surahs = jsonList.map((json) => Surah.fromJson(json)).toList();
```

# What are patterns?

- Patterns define specific **shapes** that that app data may or may not match
  - They are used to check whether or not a piece of data conforms to that pattern's shape => this is called **pattern matching**
- And then optionally, if it does, use the pattern to extract portions of the data into new variables => this is called **destructuring**
- **Main advantage:** express data shapes and extract specific parts from it in a **readable way**

# Patterns Matching

- <https://dart.dev/language/patterns>
- <https://happy-makadiya.medium.com/pattern-matching-in-dart-flutter-a-developers-playground-0f2143126acf>

# Summary

- To start thinking in the functional style ***avoid loops*** and instead use Lambdas
  - Widely used for list processing and GUI building to handle events
- A list can be processed in a pipeline
  - Typical pipeline operations are filter, map and reduce
- JSON is a very popular lightweight data format to **transform an object to a text form** to ease storing and transporting data
- Patterns are used to check whether or not a piece of data conforms to particular **shape** (i.e., **pattern matching**)
  - and then optionally, if it does, use the pattern for **destructuring** to extract portions of the data into new variables

# Resources

- Drat Collections
  - <https://dart.dev/language/collections>
- JSON serialization
  - <https://docs.flutter.dev/data-and-backend/serialization/json>
  - <https://codewithandrea.com/articles/parse-json-dart/>
  - JSON serialization package  
[https://pub.dev/packages/json\\_serializable](https://pub.dev/packages/json_serializable)
- Records
  - <https://dart.dev/language/records>
- Patterns
  - <https://dart.dev/language/patterns> & [YouTube video](#)