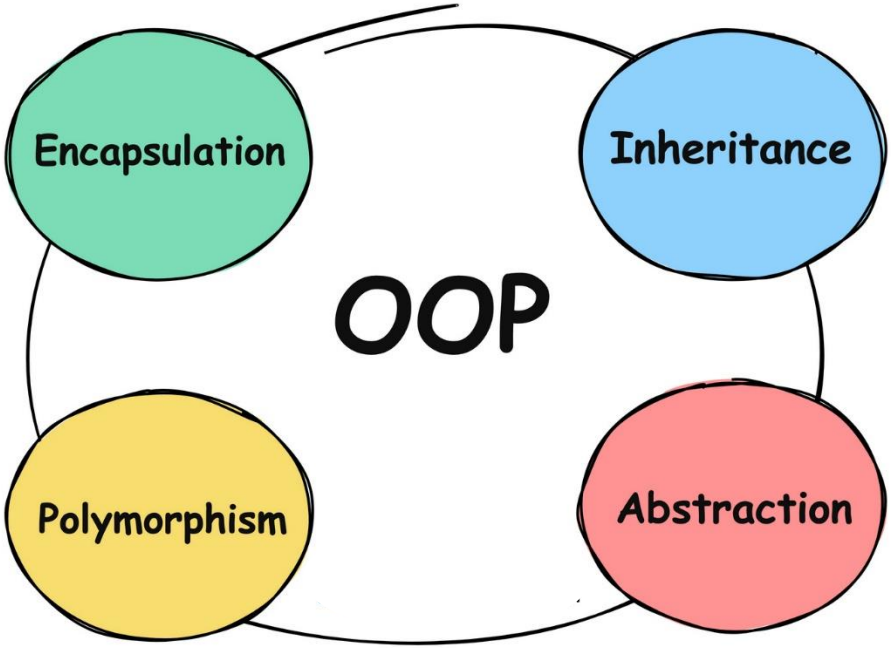
Dart


Encapsulation
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OBJECT
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Class Example

👍 **Concise**

```dart
class Person {
  // Use final for properties that
  // are initialized once and won't change
  final String firstName;
  final String lastName;
  int age;

  // Constructor with named parameters
  // Use required for non-nullable properties to ensure that
  // a value is provided during object creation
  Person({required this.firstName, required this.lastName, required this.age});

  // Computed property (getter)
  String get fullName => '$firstName $lastName';

  // Method to check if the person is a minor
  bool isMinor() => age < 18;
}
```

```dart
void main() {
  var person = Person(firstName: 'John', lastName: 'Doe', age: 17);
  print('Full name: ${person.fullName}');
  print('Is minor: ${person.isMinor()}');
}
```

Instantiate an object

Properties

Primary constructor

Computed Property

Method

Class with a computed property

```
class Rectangle {
  final int width;
  final int height;
  Rectangle({required this.width, required this.height});
  bool get isSquare  => width == height;
}
```

Note: if an attribute or method starts with an underscore _, it's private

Private attributes and methods

```
class BankAccount {
  // Private property
  double _balance = 0;

  // Public method to deposit money
  void deposit(double amount) {
      _balance += amount;
  }

  // Public method to withdraw money
  void withdraw(double amount) {
    if (_canWithdraw(amount)) {
      _balance -= amount;
    } else {
      print('Insufficient funds');
    }
  }
  // Public getter
  double get balance => _balance;

  // Private method
  bool _canWithdraw(double amount) => amount   > 0 &&
          amount <= _balance;
}
```

- Private attributes and methods are defined using an underscore (_) as a prefix
  - They can only be accessed inside the same Dart file (library), not from outside
  - Useful for **encapsulation**, hiding internal details
  - This prevents accidental misuse and enforces **controlled access**

Named Constructor

```
class Conference {
  final String name;
  final String city;
  final bool isFree;
  final double fee;

  // Primary constructor
/* : after a constructor is called an initializer list. It allows you to initialize the
attributes of a class before the constructor body runs */
  Conference({
    required this.name,
    required this.city,
  }): isFree = true, fee = 0.0;

  // Named constructor for non-free conferences
  Conference.withFee({
    required this.name,
    required this.city,
    required this.fee,
  }) : isFree = false;

  @override
  String toString()  => 'Conference: $name, City: $city, Fee: $fee, Is Free: $isFree';
}

void main() {
  var conference = Conference.withFee(name: "Flutter Conference", city: "Doha", fee: 300);
  print(conference);
}
```

cascade operator (..)

- cascade operator (..) allows you to perform a **series of operations** on the same object without having to repeat the object reference for each operation
  - Improved readability: Reduces redundancy and makes the code cleaner

```dart
class Person {
  // Private instance variable
  String _name = '';
  int _age = 0;

  void setName(String name) {
    this._name = name;
  }

  void setAge(int age) {
    this._age = age;
  }

  void greet() {
    print("Salam, my name is $_name
          and I am $_age years old.");
  }
}
```

```dart
void main() {
  // Without cascade operator
  var person1 = Person();
  person1.setName("Ali");
  person1.setAge(30);
  person1.greet();

  // With cascade operator
  var person2 = Person()
    ..setName("Fatima")
    ..setAge(25)
    ..greet();
}
```

Static Properties and Methods

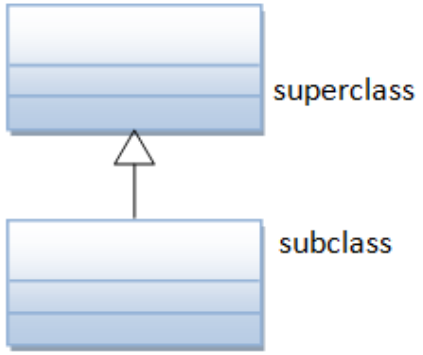
- Static properties/methods belong to the class rather than to any particular object
  - They can be called on the class itself, without creating an instance

```
class Car {
  // Static property to keep track of the number of cars created
  static int carCount = 0;
  // Instance property
  String model;

  // Constructor
  Car(this.model) {
    carCount++; // Increment car count whenever a new car is created
  }

  // Static method to get the total number of cars
  static int getCarsCount() {
    return carCount;
  }
}
```

Inheritance

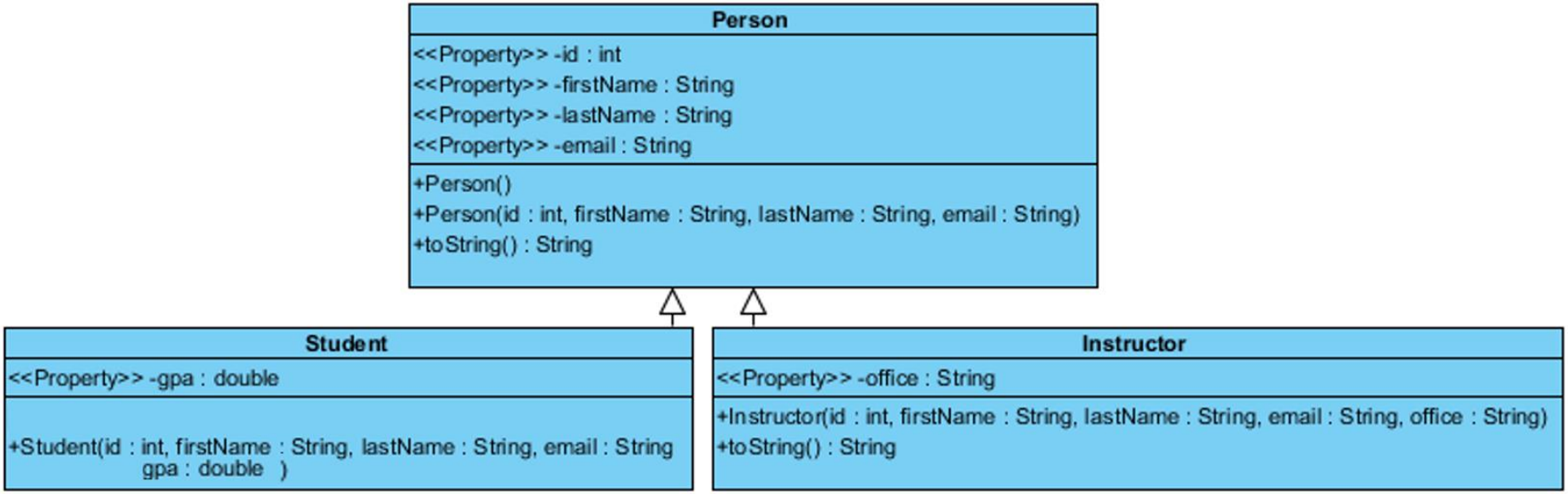


- **Ideas**
  - Common properties and methods are placed in a **superclass** (also called ***parent class*** or ***base class***)
  - You can create a subclass that **inherits** the properties and methods of the super class
    - Subclass also called ***child class***, ***subclass*** or ***derived class***
  - Subclass can extend the superclass by adding new properties/methods and/or overriding the superclass methods
- **Syntax**

```
class SubClass extends SuperClass { … }
```

- **Motivation**
  - Allow **code reuse**. **Common properties and methods are placed in a super class** then inherited by subclasses (i.e., avoids writing the same code twice to ease maintenance)

Inheritance – Person Example



- The Person class has the common properties and methods
- Each subclass can add its own specific properties and methods (e.g., `office` for Instructor and `gpa` for Student)
- Each subclass can **override** (redefine) the parent method (e.g., Instructor class overrode the toString() method).

Inheritance – Person Example

```
class Person { ... }

class Student extends Person {
  final double gpa;

/* : after a constructor is called an initializer list.
It allows you to initialize the attributes of a class or call
a superclass constructor before the constructor body runs */
  Student(String firstName, String lastName, DateTime dob, this.gpa)
      : super(firstName, lastName, dob);

  @override
  String toString() => '${super.toString()}. GPA: $gpa';
}
```

Abstract Classes

- **Idea**
  - Use an abstract class when you want to define a **template** to guarantee that all **subclasses** in a hierarchy will have certain common methods
  - Abstract classes can contain implemented methods and **abstract methods** that are NOT implemented
- Syntax

```
abstract class SomeClass {
    SomeType method1(…) // No body
    SomeType method2(…) { … } // Not abstract
}
```

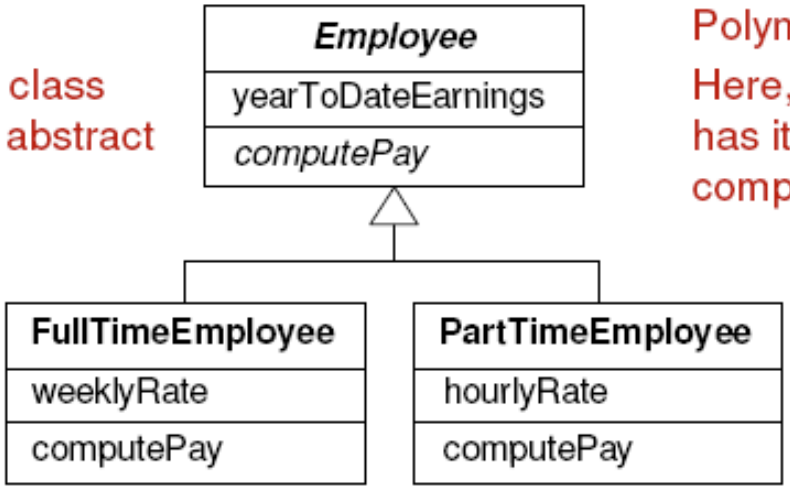
- Motivation
  - Guarantees that all subclasses will have certain methods => **enforce a common design**
  - Lets you make collections of mixed type objects that can processed polymorphically

Abstract Classes

- An abstract class has one or more abstract properties/methods that subclasses MUST override
  - Abstract properties/methods do not provide implementations because they cannot be implemented in a general way
- An abstract class cannot be instantiated

Abstraction:

Employee is an abstract class and *computePay()* is an abstract operation (italicized)



Polymorphism:

Here, each type of Employee has its own version of computePay()

Abstract Class Example

Shape.dart

```dart
abstract class Shape {
  double area();
  String get name => 'Shape';
}
```

Circle.dart

```dart
class Circle extends Shape {
  final double radius;

  Circle(this.radius);

  @override
  double area() => pi * pow(radius, 2);

  @override
  String get name => 'Circle';
}
```

Rectangle.dart

```dart
class Rectangle extends Shape {
  final double width;
  final double height;

  Rectangle(this.width, this.height);

  bool get isSquare => width == height;

  @override
  double area() => width * height;

  @override
  String get name => isSquare ? 'Square' :
            'Rectangle';
}
```

Interfaces

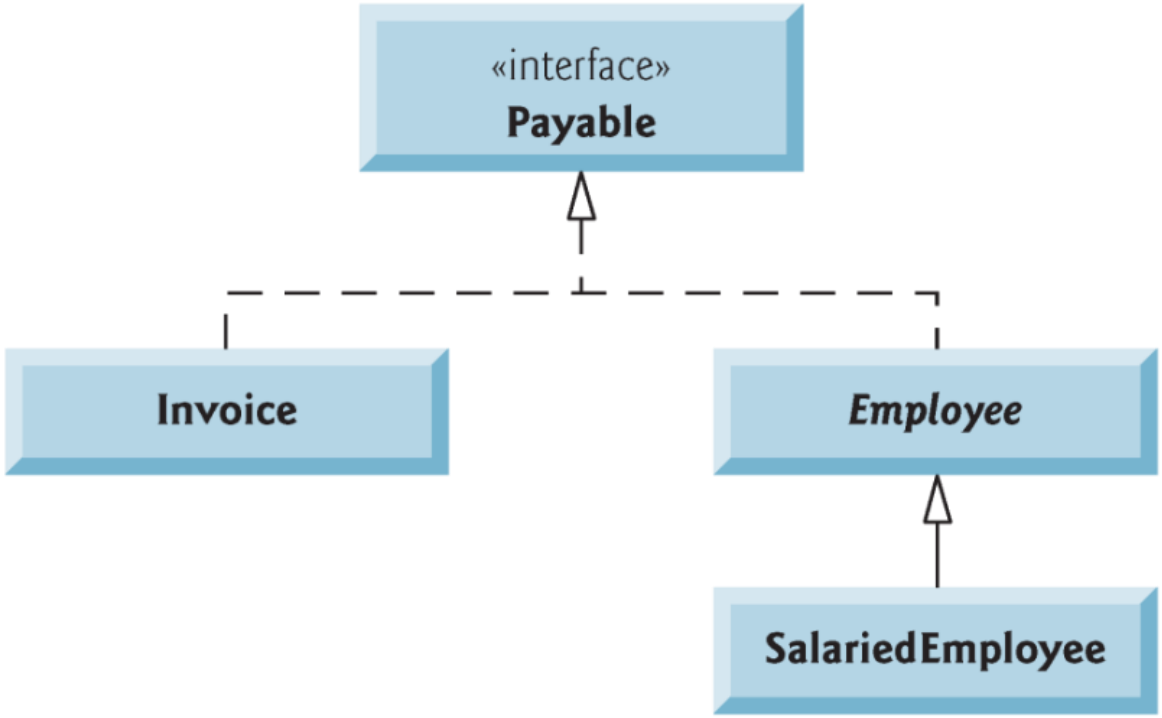
- Idea
  - **Interfaces** are used to define a set of common properties and methods that must be implemented by **classes not related by inheritance**
  - The interface specifies ***what*** methods a class must perform but does not specify ***how*** they are performed
- Syntax

```
abstract class SomeInterface {
   SomeType method1(…)      // No body
   SomeType fun method2(…) // No body
}
class SomeClass() implements SomeInterface {
  // Real definitions of method1 and method 2
}
```

- Motivation
  - Interfaces enables requiring that **unrelated classes implement a set of common methods**
  - **Ensure consistency** and guarantee that classes has certain methods:
    - Interface defines a **contract** that implementing classes must adhere to
  - Let us make **collections of mixed type** objects that can processed polymorphically

Interface Example

- A finance system has Employees and Invoices
- `Employee` and `Invoice` are not related by inheritance
  - But to the company, they are both ***Payable***



Interface Example

Payable.dart

```dart
abstract class Payable {
  double get amount;
  String pay();
}
```

Employee.dart

```dart
class Employee implements Payable {
  ...
  final double salary;

  Employee(this.firstname, this.lastname, this.salary);
  ...
  @override
  String pay() => "Pay by bank transfer
                              $firstname $salary";
}
```

Invoice.dart

```dart
class Invoice implements Payable {
  final String invoiceDate;
  final double totalAmount;

  Invoice(this.invoiceDate, this.totalAmount);
  ...
  @override
  String pay() => "Pay by Credit Card $amount";
}
```

Polymorphism Using interfaces

- A way of coding generically
  - `way of referencing many related objects as one generic type`
    - Cars and Bikes can both `move()` → refer to them as **`Transporter`** objects
    - Phones and Teslas can both `charge()` → refer to them as *`Chargeable`* objects, i.e., objects that implement **`Chargeable`** interface
    - Employees and invoices can both `pay()` → refer to them as *`Payable`* objects

```
for (var payable in payables) {
   print ( payable.pay() )
}
```

Abstract Class vs. Interface

- Abstract classes and interfaces cannot be instantiated
- Abstract classes and interfaces may have abstract methods that must be implemented by the subclasses
- Classes that implement an interface **can be from different inheritance hierarchies**
  - An interface is often used when unrelated classes need to provide **common properties and methods**
  - When a class implements an interface, it establishes a '**IS-A**' relationship with the interface type, enabling interface references to invoke polymorphic methods in a manner similar to how an abstract superclass reference can
- Concrete subclasses that extend an abstract superclass are **all related to one other by inheriting from a shared superclass**
- Classes can extend only ONE abstract class but they may implement more than one interface

Summary

- **Inheritance = "factor out" the common properties and methods and place them in a single superclass**

  => Removing code redundancy will result in a smaller, more flexible program that is easier to maintain

- Interfaces are contracts, can't be instantiated
  - force classes that implement them to define specified methods
- Polymorphism allows for generic code **by using superclass/interface type variables to manipulate objects of subclass type**
  - **make the client code more generic and ease extensibility**

Mixins

Mixins

- **Mixins** are a way to reuse code across multiple classes
  - Allowing you to add functionality to a class without extending another class
- **Difference from inheritance:**
  - **Inheritance** allows you to inherit properties and methods from **one** class, establishing an **"is-a"** relationship (e.g., a Cat is an Animal)
  - Mixins enable a class to "mix in" functionality from multiple sources **without the "is-a" relationship**, giving you more flexibility to add behaviors or functionalities to a class (e.g., a Duck can Swim and Fly)

Mixins Example

```dart
mixin CanFly {
  int flyingSpeed = 10;
  void fly() => print("I can fly at $flyingSpeed km/h!");
}

mixin CanSwim {
  int swimmingSpeed = 5;
  void swim() => print("I can swim at $swimmingSpeed km/h!");
}

class Animal {
  void breathe() => print("I can breathe!");
}

class Bird extends Animal with CanFly {
  void chirp() => print("I am chirping.");
  void setFlyingSpeed(int speed) {
    flyingSpeed = speed;
  }
}

class Duck extends Animal with CanFly, CanSwim {
  void quack() => print("I am quacking.");

  void setSpeeds(int flySpeed, int swimSpeed) {
    flyingSpeed = flySpeed;
    swimmingSpeed = swimSpeed;
  }
}
```

```dart
void main() {
  print('Bird example');
  var bird = Bird()
    ..setFlyingSpeed(20)
    ..breathe()
    ..fly()
    ..chirp();

  print('\nDuck example');
  var duck = Duck()
    ..setSpeeds(15, 10)
    ..breathe()
    ..fly()
    ..swim()
    ..quack();
}
```

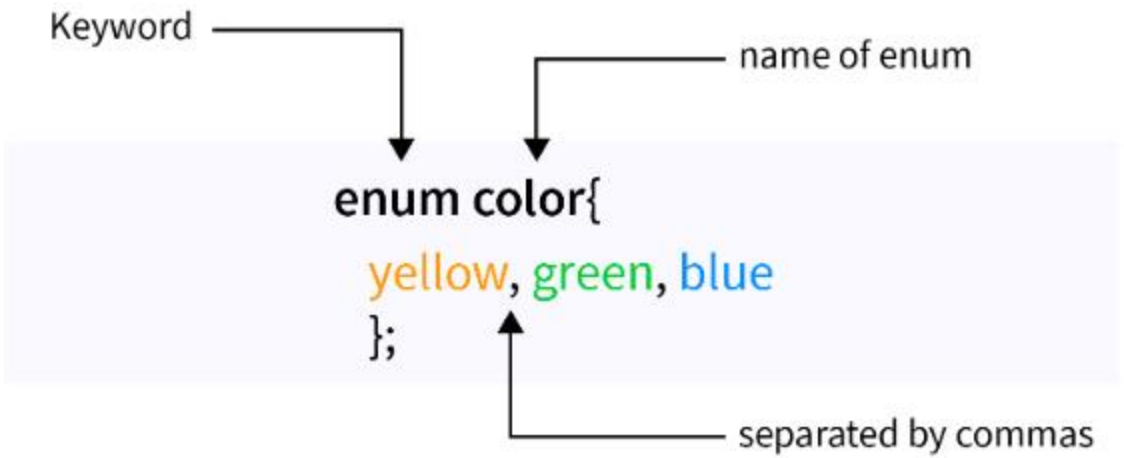
mixins properties

- **mixins** can define properties, and these properties can be accessed in the classes that use the mixin
- Example:
  - CanFly mixin defines a flyingSpeed property
  - CanSwim mixin defines a swimmingSpeed property
  - The Bird, Fish, and Duck classes access and modify these properties from the mixins
  - The setFlyingSpeed(), setSwimmingSpeed(), and setSpeeds() methods modify the speeds, and those values are used within the methods fly() and swim()

mixins access class properties and methods

- mixins can access properties from the classes that mix them in by adding superclass constraints with the **on** keyword
  - This allows mixins to require that they be mixed into classes that define certain properties or methods
- Example (see **`\5.mixins\2_mixins_vehicle.dart`**):
  - The **`ElectricVehicle`** and **`CombustionVehicle`** mixins use **on** **`Vehicle`**, to require that they be mixed into a class that extends Vehicle
  - These mixins access the name property from the Vehicle class to print the vehicle's name in their methods (`chargeBattery()`, `driveOnElectric()`, `refuel()`, and `driveOnFuel()`)
  - The **`ElectricCar`**, **`CombustionCar`**, and **`HybridCar`** classes inherit the name property and behaviors from both their mixins and the Vehicle class, and they can customize the properties such as `batteryLevel` and `fuelLevel`

Enums


Keyword
name of enum
enum color{
yellow, green, blue
};
separated by commas

enums

- enums (short for enumerations) are a special kind of class used to represent a fixed number of constant values
  - They represent a fixed number of options, such as days of the week, colors, or directions
  - Enums make the code more readable and less error-prone by limiting the possible values
  - Enable exhaustiveness checking in a switch statement
  - Enums have an implicit index starting from 0, which can be accessed using **`.index`**
  - You can retrieve all enum values using **`.values`**

```
enum Gender {
    female, male
}
enum Direction {
    left, right, up, down
}
```

Exhaustiveness checking in a switch statement

- Exhaustiveness checking ensures that every possible enum value is handled
  - Dart compiler will throw a compile-time error if not all cases are covered, ensuring safer and more reliable code

```dart
enum PaymentMethod { creditCard, paypal, bankTransfer }

String processPayment(PaymentMethod paymentMethod, double amount) {
  // Switch expression with exhaustiveness checking
  return switch (paymentMethod) {
    /* a guard condition that checks if the amount is greater than 1000.
      If true, it requires additional verification for larger payments.
    */
    PaymentMethod.creditCard when amount > 1000 => 'Additional verification required',
    PaymentMethod.creditCard => 'Payment of ${amount} via Credit Card',
    PaymentMethod.paypal => 'Payment of ${amount} via PayPal',
    PaymentMethod.bankTransfer => 'Payment of ${amount} via Bank Transfer',
  };
}
```

Enum class

- enum class can have properties, constructors, and methods, similar to a regular classes
  - Allow attaching additional data and functionality to each enum value

```
enum VehicleType {
  car(120),
  motorcycle(180),
  bicycle(25);

  final int maxSpeed;

  const VehicleType(this.maxSpeed);

  void displayInfo() {
    print('A $name can reach a max speed of $maxSpeed km/h.');
  }
}
```

Resources

- OOP
  - https://dart.dev/language/classes
  - https://dart-tutorial.com/object-oriented-programming/
- Mixins
  - https://dart.dev/language/mixins
- Enums
  - https://dart.dev/language/enums