Low Level Design Pattern

GitHub link: https://github.com/geek-shivamraj/design-patterns-2025

SOLID Principle

S – Single Responsibility Principle
O – Open/Closed Principle
L – Liskov Substitution Principle
I – Interface Segregation Principle
D – Dependency Inversion Principle

Advantages of following these principles:

Help us to write better code:
- Avoid Duplicate code
- Easy to maintain
- Easy to understand
- Flexible software
- Reduce complexity

S – Single Responsibility Principle
- A Class should have only 1 reason to change i.e., a class should have only 1 responsibility.
- Example:

Scenario:
Suppose we have an Invoice class with multiple functionality:
- Feature 1 – CalculateInvoice
- Feature 2 – PrintInvoice
- Feature 3 – SaveInvoice

Question: Is Invoice class following Single Responsibility Principle i.e., does it have only 1 reason to change?
Answer: NO

Problem:
As this class has multiple reasons to change
- Reason 1 – Suppose we want to change the calculation logic & add GST or discount then definitely calculation logic will change.
- Reason 2 – Change in Printing logic
- Reason 3 – Change in saving Invoice logic (In DB, File, Caching)

Solution:
We can split Invoice class to **CalculateInvoice**, **PrintInvoice**, **SaveInvoice**.

O – Open/Closed Principle

- Open for Extension but closed for Modification i.e., Already existing tested & deployed classes should be extended to add new functionality rather than any Modification to existing one.

Scenario:
Suppose the SaveInvoice class having **saveToDB** () method is already tested & live & now we have a new requirement to SaveInvoice to File as well.

Brute Approach:
Add a new method as **saveToFile** () in the same tested & deployed class SaveInvoice.

Problem:
With Brute approach, there is a chance that we will introduce bugs to the existing working class & that's not recommended.

Solution:
We can split Invoice class to CalculateInvoice, PrintInvoice, SaveInvoice.

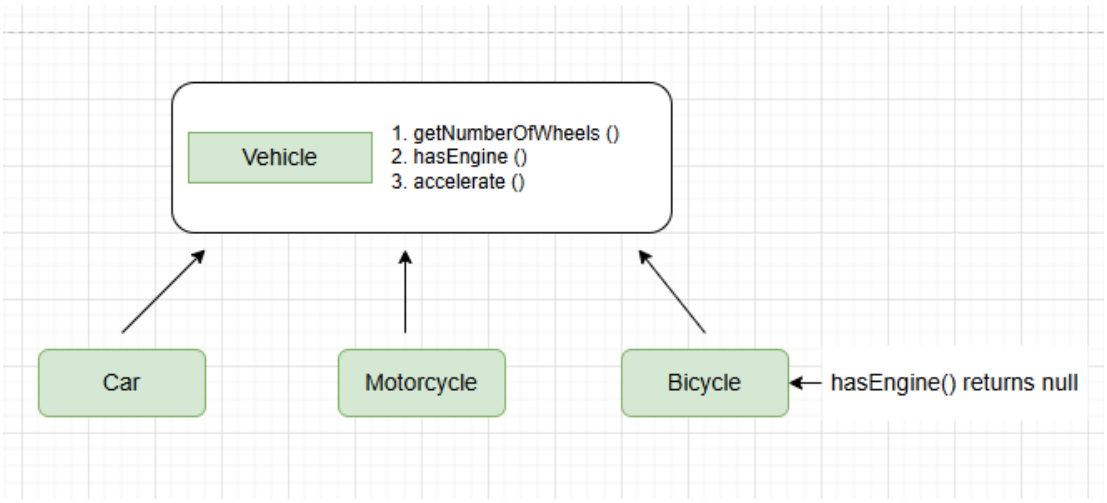
L – Liskov Substitution Principle

- If class B is a subtype of class A, then we should be able to replace object of A with B without breaking the behavior of the program.
- Subclass should extend the capability of parent class, does not narrow it down.

Scenario:
Suppose we've a class "Vehicle" having methods **getNumberOfWheels** (), **hasEngine** (), **accelerate** () & we've main client class checking whether all the classes extending Vehicle supports or extends Vehicle class functionality.

Extension to Vehicle class:

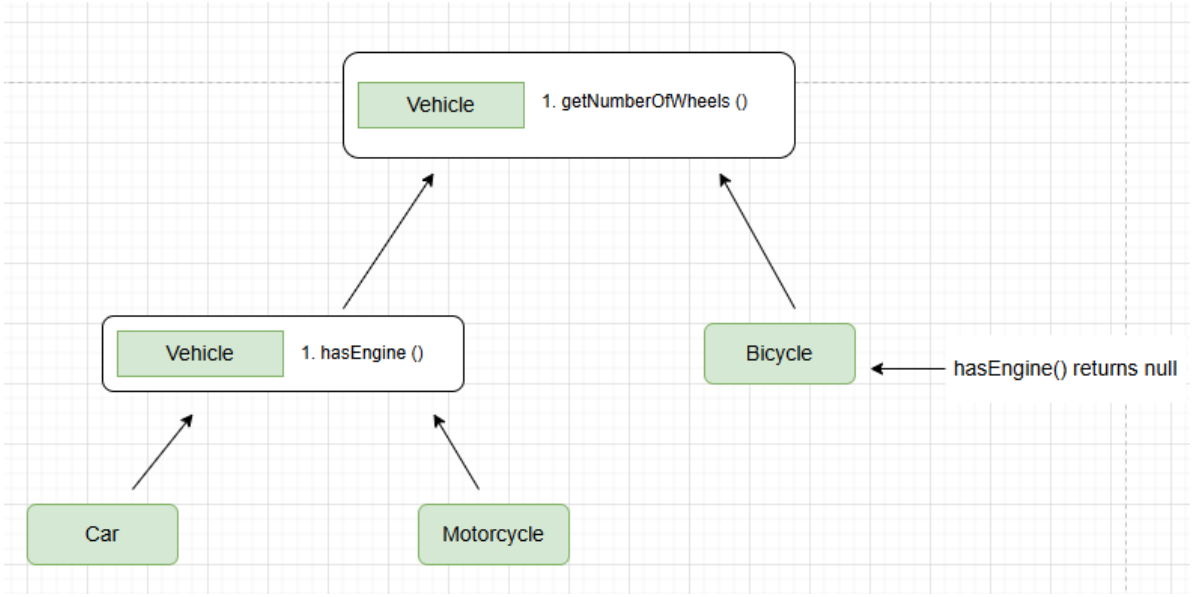
1. Car extends Vehicle – Supports all the functionality
2. Motorcycle extends Vehicle – Supports all the functionality
3. Bicycle extends Vehicle – Doesn't support hasEngine or accelerate functionality



Problem:
Vehicle class has some methods which are not relevant to all of its extension that can result in breaking the existing functionality.
E.g., I want to print Boolean whether all the Vehicle extensions hasEngine () or not

- Bicycle object can return null value that can result in **NullPointerException**

Solution:
Keep only generic methods/functionality in the super class & let the extensions have their specific functionality.



I – Interface Segregation Principle

- Interfaces should be such, that client should not implement unnecessary functions they don't need.

Scenario:
Suppose we have an interface **"RestaurantEmployee"** with below methods:

- washDishes ()
- serveCustomers ()
- cookFood ()

Now, the classes like Chef or Waiter implementing RestaurantEmployee interface have to implement all the methods, some of which are not relevant to Chef class or Waiter class.

Solution:
Segregate interface "RestaurantEmployee" into smaller interfaces such that the client doesn't have to implement methods not relevant to them.

i.e., RestaurantEmployee can be segregated to

- **WaiterInterface** with waiter specific methods like serverCustomers (), takeOrder ()
- **ChefInterface** with chef specific methods like cookFood (), decideMenu ()

D – Dependency Inversion Principle

- Class should depend on interfaces rather than concrete classes.

Scenario:

Suppose we have a class "MacBook" with keyboard & mouse dependency to it.

- Using concrete class WiredKeyboard & WiredMouse as dependency.


```
class MacBook {

    private final WiredKeyboard keyboard;
    private final WiredMouse mouse;

    public MacBook() {
        keyboard = new WiredKeyboard();
        mouse = new WiredMouse();
    }
}
```

Problem with this Approach:

- By using concrete classes instead of using interfaces like Keyboard, Mouse; we've constrained further MacBook upgradation like BluetoothKeyboard, BluetoothKeyboard.

Solution:

- By using interface as dependency, MacBook class is capable of handling both Wired & Bluetooth keyboard & Mouse.

```
class MacBook {

    private final Keyboard keyboard;
    private final Mouse mouse;

    public MacBook(Keyboard keyboard, Mouse mouse) {
        this.keyboard = keyboard;
        this.mouse = mouse;
    }
}
```