享元模式

题目链接

享元模式-图形编辑器

基础概念

享元模式是一种结构型设计模式，在享元模式中，对象被设计为可共享的，可以被多个上下文使用，而不必在每个上下文中都创建新的对象。

想要了解享元模式，就必须要区分什么是内部状态，什么是外部状态。

- 内部状态是指那些可以被多个对象共享的状态，它存储在享元对象内部，并且对于所有享元对象都是相同的，这部分状态通常是不变的。
- 而外部状态是享元对象依赖的、可能变化的部分。这部分状态不存储在享元对象内部，而是在使用享元对象时通过参数传递给对象。

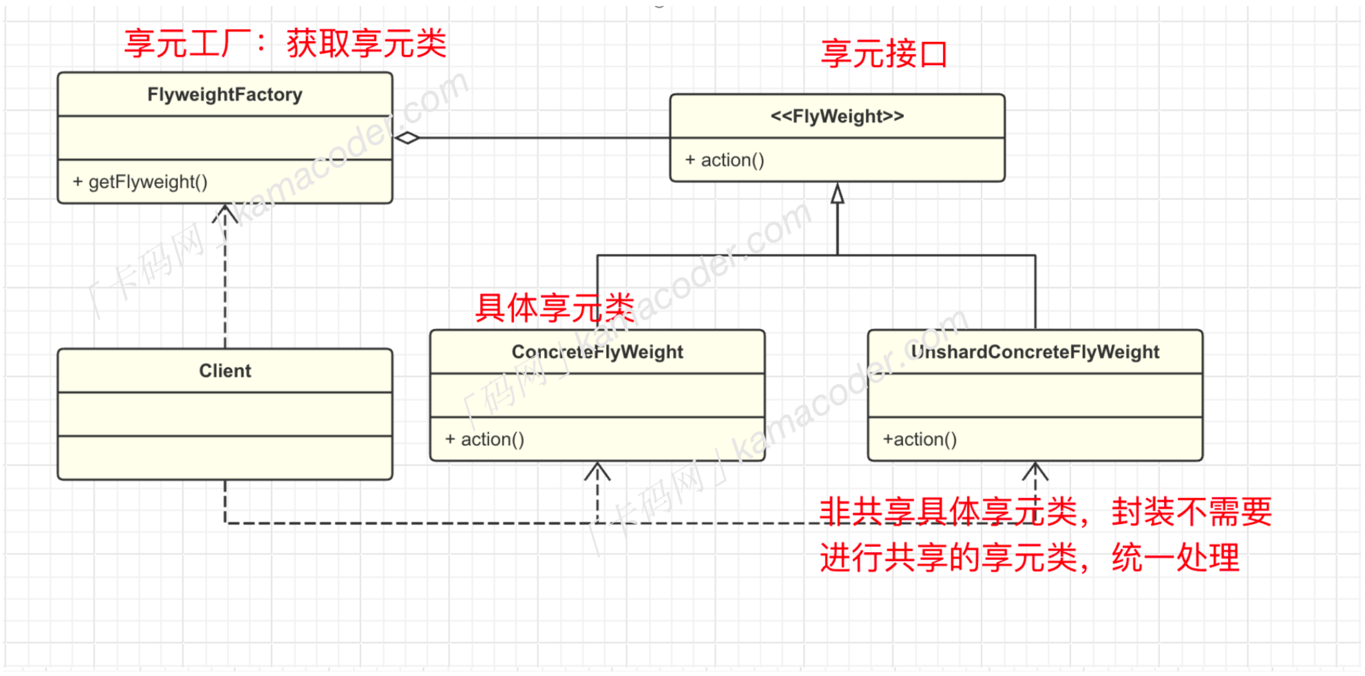
举个例子，图书馆中有很多相同的书籍，但每本书都可以被多个人借阅，图书馆里的书就是内部状态，人就是外部状态。

再举个开发中的例子，假设我们在构建一个简单的图形编辑器，用户可以在画布上绘制不同类型的图形，而图形就是所有图形对象的内部状态（不变的），而图形的坐标位置就是图形对象的外部状态（变化的）。

如果图形编辑器中有成千上万的图形对象，每个图形对象都独立创建并存储其内部状态，那么系统的内存占用可能会很大，在这种情况下，享元模式共享相同类型的图形对象，每种类型的图形对象只需创建一个共享实例，然后通过设置不同的坐标位置个性化每个对象，通过共享相同的内部状态，降低了对象的创建和内存占用成本。

基本结构

享元模式包括以下几个重要角色:



- 享元接口`Flyweight`：所有具体享元类的共享接口，通常包含对外部状态的操作。
- 具体享元类`ConcreteFlyweight`：继承`Flyweight`类或实现享元接口，包含内部状态。
- 享元工厂类`FlyweightFactory`：创建并管理享元对象，当用户请求时，提供已创建的实例或者创建一个。
- 客户端`Client`：维护外部状态，在使用享元对象时，将外部状态传递给享元对象。

简易实现

享元模式的实现通常涉及以下步骤：

1. 定义享元接口，接受外部状态作为参数并进行处理。

```
// 步骤 1: 定义享元接口
interface Flyweight {
    // 操作外部状态
    void operation(String externalState);
}
```

2. 实现具体享元类，存储内部状态。

```
// 步骤 2: 实现具体享元类
class ConcreteFlyweight implements Flyweight {
    private String intrinsicState; // 内部状态

    public ConcreteFlyweight(String intrinsicState) {
        this.intrinsicState = intrinsicState;
    }

    @Override
    public void operation(String externalState) {
        System.out.println("Intrinsic State: " + intrinsicState + ",
External State: " + externalState);
    }
}
```

3. 创建享元工厂类，创建并管理Flyweight对象，当用户请求一个Flyweight时，享元工厂会提供一个已经创建的实例或者创建一个。

```
class FlyweightFactory {
    private Map<String, Flyweight> flyweights = new HashMap<>();

    public Flyweight getFlyweight(String key) {
        if (!flyweights.containsKey(key)) {
            flyweights.put(key, new ConcreteFlyweight(key));
        }
        return flyweights.get(key);
    }
}
```

4. 客户端使用享元模式

```
public class Main {
    public static void main(String[] args) {
        FlyweightFactory factory = new FlyweightFactory();

        // 获取或创建享元对象，并传递外部状态
        Flyweight flyweight1 = factory.getFlyweight("A");
        flyweight1.operation("External State 1");

        Flyweight flyweight2 = factory.getFlyweight("B");
        flyweight2.operation("External State 2");

        Flyweight flyweight3 = factory.getFlyweight("A"); // 重复使用已存在的
享元对象
        flyweight3.operation("External State 3");
    }
}
```

使用场景

使用享元模式的关键在于包含大量相似对象，并且这些对象的内部状态可以共享。具体的应用场景包括文本编辑器，图形编辑器，游戏中的角色创建，这些对象的内部状态比较固定(外观，技能，形状)，但是外部状态变化比较大时，可以使用。

本题代码

```java
import java.util.HashMap;
import java.util.Map;
import java.util.Scanner;

enum ShapeType {
    CIRCLE, RECTANGLE, TRIANGLE
}

class Position {
    private int x;
    private int y;

    public Position(int x, int y) {
        this.x = x;
        this.y = y;
    }

    public int getX() {
        return x;
    }

    public int getY() {
        return y;
    }
}

interface Shape {
    void draw(Position position);
}

class ConcreteShape implements Shape {
    private ShapeType shapeType;

    public ConcreteShape(ShapeType shapeType) {
        this.shapeType = shapeType;
    }

    @Override
    public void draw(Position position) {
        System.out.println(shapeType + (isFirstTime ? " drawn" : " shared")
+ " at (" + position.getX() + ", " + position.getY() + ")");
    }

    private boolean isFirstTime = true;

    public void setFirstTime(boolean firstTime) {
        isFirstTime = firstTime;
    }
}

class ShapeFactory {
    private Map<ShapeType, Shape> shapes = new HashMap<>();

    public Shape getShape(ShapeType type) {
        if (!shapes.containsKey(type)) {
            shapes.put(type, new ConcreteShape(type));
        }
        return shapes.get(type);
    }
}

public class Main {
    public static void main(String[] args) {
        Scanner scanner = new Scanner(System.in);
        ShapeFactory factory = new ShapeFactory();

        while (scanner.hasNext()) {
            String command = scanner.nextLine();
            processCommand(factory, command);
        }
    }

    private static void processCommand(ShapeFactory factory, String
command) {
        String[] parts = command.split(" ");
        ShapeType type = ShapeType.valueOf(parts[0]);
        int x = Integer.parseInt(parts[1]);
        int y = Integer.parseInt(parts[2]);

        Shape shape = factory.getShape(type);
        shape.draw(new Position(x, y));
```

```
            ((ConcreteShape) shape).setFirstTime(false);
        }
    }
```

其他语言版本

C++

```
#include <iostream>
#include <unordered_map>
#include <sstream>
#include <string>

enum ShapeType {
    CIRCLE, RECTANGLE, TRIANGLE
};

std::string shapeTypeToString(ShapeType type) {
    switch (type) {
        case CIRCLE:
            return "CIRCLE";
        case RECTANGLE:
            return "RECTANGLE";
        case TRIANGLE:
            return "TRIANGLE";
        default:
            return "UNKNOWN";
    }
}

class Position {
private:
    int x;
    int y;

public:
    Position(int x, int y) : x(x), y(y) {}

    int getX() const {
        return x;
    }

    int getY() const {
        return y;
    }
};

class Shape {
public:
    virtual void draw(const Position &position) = 0;
    virtual ~Shape() {}
};

class ConcreteShape : public Shape {
private:
    ShapeType shapeType;
    bool isFirstTime;

public:
    ConcreteShape(ShapeType shapeType) : shapeType(shapeType),
isFirstTime(true) {}

    void draw(const Position &position) override {
        std::cout << shapeTypeToString(shapeType) << (isFirstTime ? "
drawn" : " shared") << " at (" << position.getX() << ", " <<
position.getY() << ")\n";
    }

    void setFirstTime(bool firstTime) {
        isFirstTime = firstTime;
    }
};

class ShapeFactory {
private:
    std::unordered_map<ShapeType, Shape *> shapes;

public:
    Shape *getShape(ShapeType type) {
        if (shapes.find(type) == shapes.end()) {
            shapes[type] = new ConcreteShape(type);
        }
        return shapes[type];
    }

    ~ShapeFactory() {
        for (const auto &entry : shapes) {
            delete entry.second;
        }
    }
};
```

```cpp
void processCommand(ShapeFactory &factory, const std::string &command);

int main() {
    ShapeFactory factory;
    std::string command;

    while (std::getline(std::cin, command)) {
        processCommand(factory, command);
    }

    return 0;
}

void processCommand(ShapeFactory &factory, const std::string &command) {
    std::istringstream iss(command);
    std::string shapeTypeStr;
    int x, y;

    iss >> shapeTypeStr >> x >> y;

    ShapeType type;
    if (shapeTypeStr == "CIRCLE") {
        type = CIRCLE;
    } else if (shapeTypeStr == "RECTANGLE") {
        type = RECTANGLE;
    } else if (shapeTypeStr == "TRIANGLE") {
        type = TRIANGLE;
    } else {
        std::cerr << "Invalid shape type: " << shapeTypeStr << std::endl;
        return;
    }

    Shape *shape = factory.getShape(type);
    shape->draw(Position(x, y));
    dynamic_cast<ConcreteShape *>(shape)->setFirstTime(false);
}
```

Python

```python
from enum import Enum
from typing import Dict

class ShapeType(Enum):
    CIRCLE = "CIRCLE"
    RECTANGLE = "RECTANGLE"
    TRIANGLE = "TRIANGLE"

class Position:
    def __init__(self, x, y):
        self.x = x
        self.y = y

class Shape:
    def draw(self, position: Position):
        pass

class ConcreteShape(Shape):
    def __init__(self, shape_type: ShapeType):
        self.shape_type = shape_type
        self.is_first_time = True

    def draw(self, position: Position):
        print(f"{self.shape_type.value}{' drawn' if self.is_first_time else
' shared'} at ({position.x}, {position.y})")

    def set_first_time(self, first_time: bool):
        self.is_first_time = first_time

class ShapeFactory:
    def __init__(self):
        self.shapes: Dict[ShapeType, Shape] = {}

    def get_shape(self, shape_type: ShapeType) -> Shape:
        if shape_type not in self.shapes:
            self.shapes[shape_type] = ConcreteShape(shape_type)
        return self.shapes[shape_type]

def process_command(factory: ShapeFactory, command: str):
    parts = command.split(" ")
    shape_type = ShapeType(parts[0])
    x = int(parts[1])
    y = int(parts[2])

    shape = factory.get_shape(shape_type)
    shape.draw(Position(x, y))
    shape.set_first_time(False)

if __name__ == "__main__":
    factory = ShapeFactory()

    while True:
        try:
            command = input()
            process_command(factory, command)
        except EOFError:
            break
```

Go

```
package main

import (
    "bufio"
    "fmt"
    "os"
    "strconv"
    "strings"
)

type ShapeType int

const (
    CIRCLE    ShapeType = iota
    RECTANGLE
    TRIANGLE
)

var shapeTypeStrings = [...]string{
    "CIRCLE",
    "RECTANGLE",
    "TRIANGLE",
}

type Position struct {
    X, Y int
}

type Shape interface {
    Draw(Position)
}

type ConcreteShape struct {
    ShapeType   ShapeType
    IsFirstTime bool
}

func NewConcreteShape(shapeType ShapeType) *ConcreteShape {
```

```go
    return &ConcreteShape{
        ShapeType:   shapeType,
        IsFirstTime: true,
    }
}

func (s *ConcreteShape) Draw(position Position) {
    fmt.Printf("%s %s at (%d, %d)\n", s.ShapeType.String(),
s.getTimeDescription(), position.X, position.Y)
}

func (s *ConcreteShape) setFirstTime(firstTime bool) {
    s.IsFirstTime = firstTime
}

func (s *ConcreteShape) getTimeDescription() string {
    if s.IsFirstTime {
        return "drawn"
    }
    return "shared"
}

func (st ShapeType) String() string {
    if st >= 0 && int(st) < len(shapeTypeStrings) {
        return shapeTypeStrings[st]
    }
    return "UNKNOWN"
}

type ShapeFactory struct {
    shapes map[ShapeType]Shape
}

func NewShapeFactory() *ShapeFactory {
    return &ShapeFactory{
        shapes: make(map[ShapeType]Shape),
    }
}

func (f *ShapeFactory) getShape(shapeType ShapeType) Shape {
    if _, exists := f.shapes[shapeType]; !exists {
        f.shapes[shapeType] = NewConcreteShape(shapeType)
    }
    return f.shapes[shapeType]
}
```

```go
func main() {
    var factory = NewShapeFactory()

    scanner := bufio.NewScanner(os.Stdin)
    for scanner.Scan() {
        command := scanner.Text()
        processCommand(factory, command)
    }

    if err := scanner.Err(); err != nil {
        fmt.Println("Error reading standard input:", err)
    }
}

func processCommand(factory *ShapeFactory, command string) {
    parts := splitCommand(command)
    shapeType := ShapeTypeFromString(parts[0])
    x, _ := strconv.Atoi(parts[1])
    y, _ := strconv.Atoi(parts[2])

    shape := factory.getShape(shapeType)
    shape.Draw(Position{X: x, Y: y})
    concreteShape, ok := shape.(*ConcreteShape)
    if ok {
        concreteShape.setFirstTime(false)
    }
}

func splitCommand(command string) []string {
    return splitWithoutEmpty(command, ' ')
}

func splitWithoutEmpty(s string, sep byte) []string {
    parts := strings.FieldsFunc(s, func(r rune) bool {
        return r == rune(sep)
    })
    return parts
}

func ShapeTypeFromString(s string) ShapeType {
    for i, str := range shapeTypeStrings {
        if str == s {
            return ShapeType(i)
        }
    }
    return CIRCLE
    }
```