State Pattern - Managing Object States Dynamically

What is the State Pattern?

The **State Pattern** is a behavioral design pattern that allows an object to alter its behavior when its internal state changes. It encapsulates state-specific behavior into separate state classes and delegates state-related work to an instance of these classes.

This pattern is often compared to a **finite state machine**, where the object can switch between predefined states based on events.

Key Components of the State Pattern

1. **State Interface**:
    - Defines the common behavior for all concrete states.
2. **Concrete State Classes**:
    - Implement specific behaviors associated with each state.
3. **Context (Main Object)**:
    - Maintains a reference to the current state object and delegates requests to it.

Why Use the State Pattern?

- **Encapsulation of State-Specific Behavior**: Keeps state-specific behavior separate from the context class.
- **Improved Maintainability**: Simplifies modifications by isolating changes to specific states.
- **Eliminates Conditional Logic**: Avoids large `if-else` or `switch` statements for state transitions.

How It Works

1. Define a **State Interface** with methods that handle state-specific behavior.
2. Create **Concrete State Classes** that implement the state interface.
3. The **Context** class holds a reference to the current state and delegates requests to it.
4. State transitions are managed by the state classes or the context class.

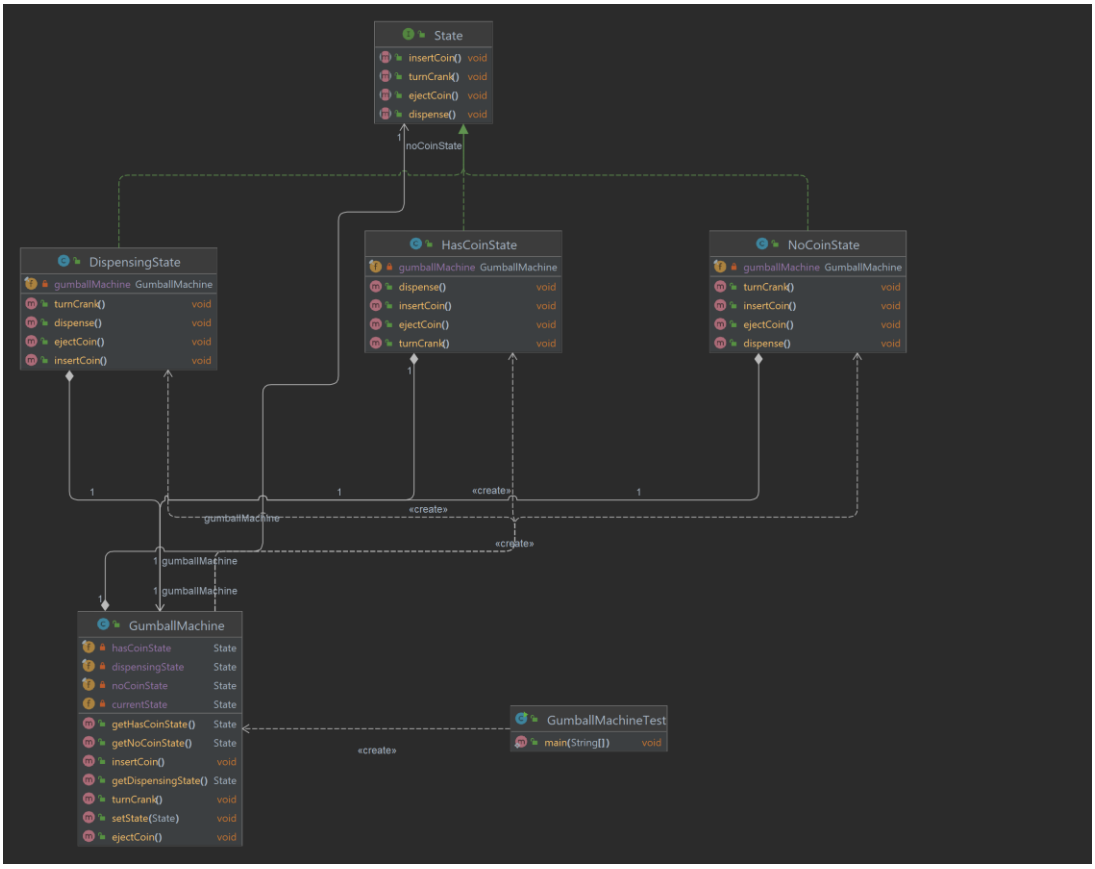
Project Structure

```
src/main/java/com/headfirst/chapter10/statePattern/
├── gumballmachine/
│   ├── State.java                      # State Interface
│   ├── NoCoinState.java                # Concrete State 1
│   ├── HasCoinState.java               # Concrete State 2
│   ├── DispensingState.java            # Concrete State 3
│   ├── GumballMachine.java             # Context
│   └── GumballMachineTest.java         # Client
└── trafficlight/
    ├── TrafficLightState.java          # State Interface
    ├── RedLightState.java              # Concrete State 1
    ├── GreenLightState.java            # Concrete State 2
    ├── YellowLightState.java           # Concrete State 3
    ├── TrafficLight.java               # Context
    └── TrafficLightTest.java           # Client
```

Example: Gumball Machine

The classic gumball machine example illustrates how the State Pattern handles different states like “No Coin”, “Has Coin”, “Dispensing Gumball”, etc.

Class Diagram



Example Code

State Interface

```
public interface State {
    void insertCoin();
    void ejectCoin();
    void turnCrank();
    void dispense();
}
```

Concrete State 1: NoCoinState

```
public class NoCoinState implements State {
    private final GumballMachine gumballMachine;

    public NoCoinState(GumballMachine gumballMachine) {
        this.gumballMachine = gumballMachine;
    }
    @Override
    public void insertCoin() {

        System.out.println("Coin inserted. You can turn the crank
        now.");
        gumballMachine.setState(gumballMachine.getHasCoinState());
    }

    @Override
    public void ejectCoin() {
        System.out.println("No coin to eject.");
    }

    @Override
    public void turnCrank() {
        System.out.println("Insert a coin first.");
    }

    @Override
    public void dispense() {
        System.out.println("No gumball dispensed.");
    }
}
```

Concrete State 2: HasCoinState

```
public class HasCoinState implements State {
    private final GumballMachine gumballMachine;

    public HasCoinState(GumballMachine gumballMachine) {
        this.gumballMachine = gumballMachine;
    }

    @Override
    public void insertCoin() {
        System.out.println("Coin already inserted.");
    }

    @Override
    public void ejectCoin() {
        System.out.println("Coin ejected.");
        gumballMachine.setState(gumballMachine.getNoCoinState());
    }
    @Override
    public void turnCrank() {
        System.out.println("Crank turned. Dispensing
        gumball...");
        gumballMachine.setState(gumballMachine.getDispensingState());
    }

    @Override
    public void dispense() {
        System.out.println("Turn the crank to dispense.");
    }
}
```

Context: GumballMachine

```
public class GumballMachine {
    private final State noCoinState;
    private final State hasCoinState;
    private final State dispensingState;

    private State currentState;

    public GumballMachine() {
        noCoinState = new NoCoinState(this);
        hasCoinState = new HasCoinState(this);
        dispensingState = new DispensingState(this);

        currentState = noCoinState; // Initial state
```

```
    }

    public void setState(State state) {
        this.currentState = state;
    }

    public State getNoCoinState() {
        return noCoinState;
    }

    public State getHasCoinState() {
        return hasCoinState;
    }

    public State getDispensingState() {
        return dispensingState;
    }
    public void insertCoin() {
        currentState.insertCoin();
    }

    public void ejectCoin() {
        currentState.ejectCoin();
    }

    public void turnCrank() {
        currentState.turnCrank();
        currentState.dispense();
    }
}
```

Client

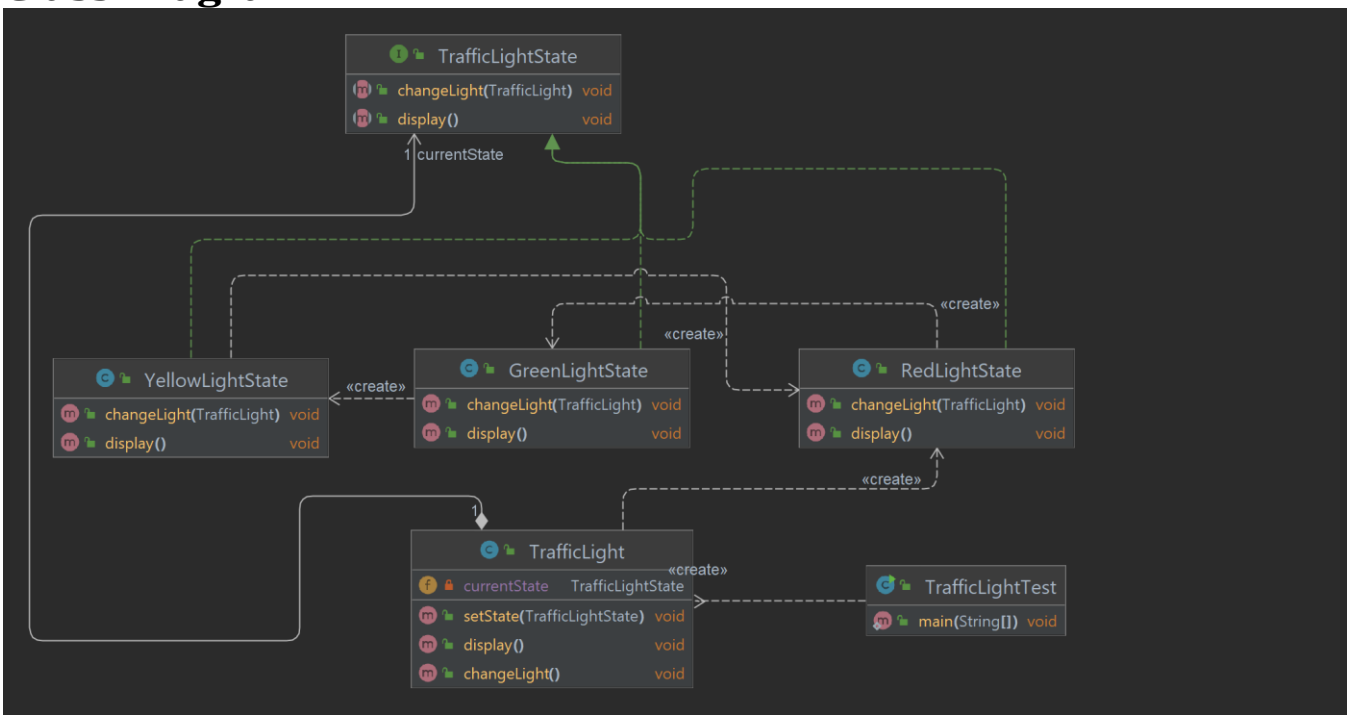
```
public class GumballMachineTest {
    public static void main(String[] args) {
        GumballMachine gumballMachine = new GumballMachine();

        gumballMachine.insertCoin();
        gumballMachine.turnCrank();

        gumballMachine.insertCoin();
        gumballMachine.ejectCoin();
    }
}
```

Real-World Applications

Example: Traffic Light System

The traffic light system is a real-world example of the State Pattern. It demonstrates how traffic lights transition between states like “Red”, “Green”, and “Yellow” while maintaining state-specific behavior.

Class Diagram



Example-Code

State Interface

```
public interface TrafficLightState {
    void changeLight(TrafficLight context);
    void display();
}
```

Concrete State 1: RedLightState

```
/**
 * Red Light state implementation.
 */
public class RedLightState implements TrafficLightState {
    @Override
    public void changeLight(TrafficLight context) {
        System.out.println("Changing light to Green.");
        context.setState(new GreenLightState());
    }

    @Override
    public void display() {
        System.out.println("Red Light - STOP!");
```

```
    }
}
```

Concrete State 2: GreenLightState

```
/**
 * Green Light state implementation.
 */
public class GreenLightState implements TrafficLightState {
    @Override
    public void changeLight(TrafficLight context) {
        System.out.println("Changing light to Yellow.");
        context.setState(new YellowLightState());
    }

    @Override
    public void display() {
        System.out.println("Green Light - GO!");
    }
}
```

Concrete State 3: YellowLightState

```
/**
 * Yellow Light state implementation.
 */
public class YellowLightState implements TrafficLightState {
    @Override
    public void changeLight(TrafficLight context) {
        System.out.println("Changing light to Red.");
        context.setState(new RedLightState());
    }

    @Override
    public void display() {
        System.out.println("Yellow Light - SLOW DOWN!");
    }
}
```

Context: TrafficLight

```
/**
 * Context for managing traffic light states.
 */
public class TrafficLight {
    private TrafficLightState currentState;

    public TrafficLight() {
        currentState = new RedLightState(); // Initial state
```

```
    }

    public void setState(TrafficLightState state) {
        currentState = state;
    }

    public void changeLight() {
        currentState.changeLight(this);
    }

    public void display() {
        currentState.display();
    }
}
```

Client: TrafficLightTest

```
/**
 * Client to test the Traffic Light System using the State
       Pattern.
 */
public class TrafficLightTest {
    public static void main(String[] args) {
        TrafficLight trafficLight = new TrafficLight();

        trafficLight.display();
        trafficLight.changeLight();

        trafficLight.display();
        trafficLight.changeLight();
    }
}
```

More Examples

1. ATMs: Handles states like “Card Inserted”, “PIN Entered”, “Transaction In Progress”.
2. Media Players: Manages states like “Playing”, “Paused”, “Stopped”.

Summary Table

Component	Responsibility
State Interface	Defines common behavior for all states
Concrete State	Implements specific behavior for each state
Context	Maintains current state and delegates behavior

The State Pattern is a powerful tool for managing objects with complex and dynamic state transitions. It eliminates conditional logic, improves code maintainability, and aligns well with real-world scenarios!