JavaScript Design Patterns

CS445 Modern Asynchronous Programming

Maharishi University of Management

Department of Computer Science

Teaching Faculty: Assistant Professor Umur Inan

Prepared by: Associate Professor Asaad Saad

The Facade Pattern

When we put up a facade, we present an **outward appearance** to the world which may **conceal a very different reality**.

This pattern is a structural pattern, it provides a convenient higher-level interface to a larger body of code, hiding its true underlying complexity. Think of it as simplifying the API being presented to other developers, something which almost always improves usability.

Façade Pattern Example

```
const Mortgage = function (name) {
    this.name = name;
}

Mortgage.prototype = {
    applyFor: function (amount) {
        let result = "approved";
        // call subsystems
        // check if account exists
        // check if client has good credit score
        // check if amount is within the approved range
        return `${this.name} has been ${result} for a ${amount} mortgage`;
    }
}

const mortgage = new Mortgage("Asaad Saad");
const result = mortgage.applyFor("$100,000");
```

The Factory Pattern

The Factory pattern is a creational pattern concerned with the notion of **creating objects**. Where it differs from the other patterns in its category is that it doesn't explicitly require us to use a constructor. Instead, a Factory can provide a generic interface for creating objects, where we can specify the **type of object** we wish to be created.

Rather than creating an object directly using the **new** operator or via another creational constructor, we ask a Factory object for a new object instead. We inform the Factory what type of object is required and it instantiates this, returning it to us for use.

This is particularly useful if the object creation process is relatively complex, like if it strongly depends on dynamic factors or application configuration.

Factory Pattern Example

```
function Mahler(options) {
    this.clef = options.clef || "treble";
    this.signature = options.signature || "4-flat";
    this.tempo = options.tempo || 75;
}
function Bruckner(options) {
    this.clef = options.clef || "bass";
    this.tone = options.tone || "aria";
}
createMelody = function (options) {
    switch (options.clef) {
        case "treble": return new Mahler(options);
        case "bass": return new Bruckner(options);
    }
};

const melody = createMelody({
    clef: "treble",
    signature: "1-flat",
    tempo: 102
});
```

The Decorator Pattern

The Decorator pattern extends (decorates) an object’s behavior dynamically. The ability to add new behavior at runtime is accomplished by a Decorator object which wraps around the original object. Multiple decorators can add or override functionality to the original object.

Decorator Pattern Example

```
const User = function (name) {
    this.name = name;
    this.log = () => console.log("User: " + this.name);
}

const DecoratedUser = function (user, city, state) {
    this.name = user.name;
    this.city = city;
    this.state = state;
    this.log = () => console.log(`User: ${this.name}, ${this.city}, ${this.state}`);

}

const user = new User("Asaad");
user.log();

const decorated = new DecoratedUser(user, "Fairfield", "Iowa");
decorated.log();
```

The Strategy Pattern

Define a **family of algorithms, encapsulate each one, and make them interchangeable.** Strategy lets the algorithm vary independently from clients that use it.

The Strategy pattern encapsulates alternative algorithms (or strategies) for a particular task. It allows a method to be swapped out at runtime by any other strategy.

The Strategy Pattern Example

Given the following three shipping strategies:

```
class UPS {
    calculate(product) { return "$45.95" }
};

class USPS {
    calculate(product) { return "$39.40" }
};

class Fedex {
    calculate(product) { return "$43.20" }
};
```

The Strategy Pattern Example

We can implement the strategy pattern and encapsulate each one of them, and make them interchangeable.

```
class Shipping {
    shippingCompany = "";

    setStrategy(shippingCompany) {
        this.shippingCompany = shippingCompany;
    }

    calculate(product) {
        return this.shippingCompany.calculate(product);
    }
};
```

The Strategy Pattern Example

That makes it easier for the client to choose their strategy:

```
const product = { from: "52556", to: "10012", weight: "1kg" };

const ups = new UPS();
const usps = new USPS();
const fedex = new Fedex();

const shipping = new Shipping();

shipping.setStrategy(ups);
console.log("UPS Strategy: " + shipping.calculate(product));
shipping.setStrategy(usps);
console.log("USPS Strategy: " + shipping.calculate(product));
shipping.setStrategy(fedex);
console.log("Fedex Strategy: " + shipping.calculate(product));
```

Memoization

Design patterns define how more than one relatively complex class/object interact. This involves high level of abstraction.

Memoization is a **coding/optimization technique** that speeds up applications by storing the results of expensive function calls and returning the cached result when the same inputs are supplied again.

An **expensive function call** is a function call that consumes huge chunks of these time or memory during execution due to heavy computation.

A **cache** is simply a temporary data store that holds data so that future requests for that data can be served faster.

How Does Memoization Work?

The concept of memoization in JavaScript is built majorly on two concepts:

- Closures
- Higher Order Functions

When to Memoize a Function?

- Expensive function calls (functions that carry out heavy computations)
- Functions with a limited and highly recurring input range.
- Recursive functions with recurring input values.
- Pure functions (functions that return the same output each time they are called with a particular input).

Case Study: The Fibonacci Sequence

Write a function to return the **`nth`** element in the Fibonacci sequence, where the sequence is:

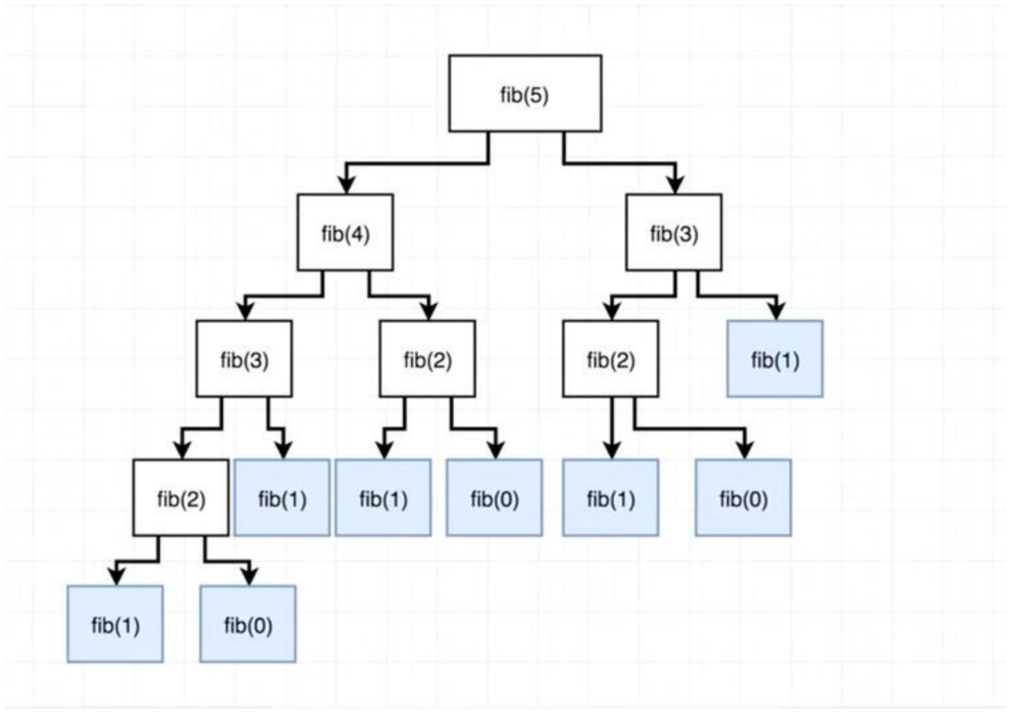
`[1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, …]`

```
function fibonacci(n) {
    if (n <= 1) {
        return 1
    }
    return fibonacci(n - 1) + fibonacci(n - 2);
}
```

Analyze the solution

Looking at the diagram, when we try to evaluate **`fib(5)`**, we notice that we repeatedly try to find the Fibonacci number at indices **`0`**, **`1`**, **`2`** and **`3`** on different branches.

This is known as redundant computation and is exactly what memoization stands to eliminate.



Optimized Solution

```
function fibonacci(n, memo={}) {
    if (memo[n]) {
        return memo[n]
    }
    if (n <= 1) {
        return 1
    }
    return memo[n] = fibonacci(n - 1, memo) + fibonacci(n - 2, memo)
}
```

A Functional Approach

```
function memoizer(fn){
    let cache = {}
    return function (n){
        if (cache[n] != undefined ) {
          return cache[n]
        } else {
          let result = fn(n)
          cache[n] = result
          return result
        }
    }
}
const fibonacciMemoFunction = memoizer(fibonacciRecursive)
```