Design Principles

aka Object Oriented Programming

July 4, 2017

Encapsulate what varies.

- Encapsulate . . .
  - Restrict outside access to a things parts.
  - Bundle operations with the things they use.
- . . . what varies.
  - This refers to source code.
  - Source code varies due to changing requirements.
  - Requirements change for a lots of reasons.
  - E.g. A change in government may cause a change in tax law.
- Restrict outside access to parts of the source code that might change due to changing requirements.
- "what [do] you want to be *able* to change without redesign?" (Gamma et al, 1977)

```typescript
class Product {
    public price: number;
}

// We have encapsulated the calculation of tax.
class TaxCalculator {
    public calculateTax(product: Product): number {
        throw new Error("TODO: Calculate the tax on the product.");
    }
}

class FarmStand {

    private cart: Array<Product>;

    public DisplayGrandTotal(): number {
        const taxCalculator = new TaxCalculator();

        return this.cart.reduce((sum, product) => {
            // Question: What else might we want to change without redesign?
            const tax = taxCalculator.calculateTax(product);
            const productGrandTotal = tax + product.price;
            return sum + productGrandTotal;
        }, 0);
    }
}
```

Program to interfaces not to implementations.

- an interface says only what requests it will receive
- an implementation says how it will handle those requests
- programming to interfaces helps because it
    - lets us easily change an implementation, even at runtime
    - allows applications to send the same request to different classes

```
export interface Juiceable {
    squeeze(): Juice;
}

class Orange implements Juiceable {
    public squeeze() {
        return new Juice("orange juice");
    }
}

class Carrot implements Juiceable {
    public squeeze() {
        return new Juice("carrot juice");
    }
}

class Juice {
    constructor(private name: string) { }
}

class JuiceGarden {

    pickOrange(): Juiceable {
        return new Orange();
    }

    pickCarrot(): Juiceable {
        return new Carrot();
    }
}

// The juicer is programming to interfaces.
// The following only cares that it is dealing with Juiceables.
function orangeCarrotJuice(juiceGarden: JuiceGarden): Array<Juice> {

    const orange: Juiceable = juiceGarden.pickOrange();
    const carrot: Juiceable = juiceGarden.pickCarrot();
```

Depend on abstractions not on concrete classes.

- interfaces and abstractions are similar: neither can exist
- concrete classes can exist (i.e. can become objects)
- to depend on something means a direct reference to it
- The Dependency Inversion Principle (Martin, 1996)
  - Traditionally, high-level modules depend on low-level modules:
  - Higher $\rightarrow$ Middle $\rightarrow$ Lower $\rightarrow$ ...
  - Dependency Inversion inverts that:
  - Higher $\rightarrow$ Abstraction $\leftarrow$ Middle $\rightarrow$ Abstraction $\leftarrow$ Lower ...
- When layering, higher-levels define the abstractions
- and lower-levels implement the abstractions.

```typescript
// This is dependency inversion.
// Both the higher-level juicer and the lower-level components
// depend on an abstraction.
export function juicer(ingredients: Array<Juiceable>): Array<string> {
    // Dependency inversion leverages programming to interfaces.
    return ingredients.map((i) => i.juice());
}

export interface Juiceable {
    juice(): string;
}

// orange and carrot are lower-level modules
export class Orange implements Juiceable {
    public juice() {
        return "orange juice";
    }
}

export class Carrot implements Juiceable {
    public juice() {
        return "carrot juice";
    }
}
```

- Inversion of Control

- The Single Responsibility Principle ()

Classes should be open to extension and closed for modification.

- The Open-Closed Principle ()

- The Liskov Substitution Principle ()

- The Law of Demeter ()
- The Princple of Least Knowledge

Strive for loosely coupled designs among objects that interact.

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