面向对象设计入门

文泰来 老师

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课程大纲

- 什么是OOD
- 这门课是否适合我
- OOD面试当中的陷阱
- 如何评判OOD面试的好坏
- 5C解题法
- 实战演练：Design elevator system
- 后续课程介绍

OOD介绍

- OOD vs. System Design
- OOA vs. OOD vs. OOP
- 面试频率
- 面试当中的重要性
- OOD介绍小结

OOD vs. System Design

	Object Oriented Design	System Design
面试者	应届毕业生，SDE I -	有经验的面试者， SDE I +
出题目的	OOD常被当做考察面试者综合素质的标准	需要处理大量数据，提供Service的部门
常见公司	Amazon, Bloomberg,...	Facebook, Google,...
关键字	Viability	Scalability
例题	Design Elevator System	Design Twitter

OOD和面试

These questions are not so much about regurgitating design patterns as they are about demonstrating that you understand how to create elegant, maintainable object-oriented code. Poor performance on this type of question may raise serious red flags.

- 面试频率：
  - Phone interview 低
  - Onsite interview 中高频
- 高频公司：
  - Amazon, Bloomberg, TripAdvisor, EMC, Uber…

OOD和面试

- 出题问法
  - Can you design an elevator system? (设计一个完整的系统)
    - Little amount of coding
  - Can you design scheduler for elevator system? (设计系统中的一个部分)
    - Need implementation

OOD介绍小结

OOD在面试当中很重要

- 尤其对于Intern和Entry level

题目没有标准答案

- Everything is an object

题目类型明显，可用固定的模板解题

课程要求

- Coding skill
  - Java entry level，有基本的Java知识，了解基本的data structure如Array, List, HashMap等
- Design pattern
  - 不需要design pattern的基础，我们将会在课程中讲解如何运用常见的design pattern来为面试加分
- Time commitment
  - 每节课时2小时，一周两节课，一共五节课10小时
  - Lintcode 做题，每周一小时

OOD面试中的陷阱

- 起手式的陷阱
- 解题中的陷阱
- 收手式的陷阱

起手式的陷阱

- 先下手为强

例子:

Okay, for a parking lot, we need multiple levels. Also let's make it able to park bicycles.

忌：自说自话，侃侃而谈

宜：先通过和面试官的交流获得有效信息

起手式的陷阱

- 指鹿为马

例子:

Let's say you need to support 5000 people to park in this parking lot, morning and night will be your peak hour...

I can try to use this algorithm/data structure to find the closest spot.

忌：Algorithm, OOD, System design 傻傻分不清楚

宜：询问清楚题目要求

解题中的陷阱

- 朝出夕改

例子:

Oh, wait a second, I think I can optimize the process by modifying/removing this class

忌：思路混乱，反复修改

宜：先给面试官呈现一个Viable的成果

收手式的陷阱

- 虎头蛇尾

忌：虎头蛇尾，功亏一篑
宜：检查你的设计，是否能够支持所需的功能

S.O.L.I.D原则

- S – Single responsibility principle
- O – Open close principle
- L – Liskov substitution principle
- I – Interface segregation principle
- D – Dependency inversion principle

S.O.L.I.D原则

- Single responsibility principle 单一责任原则

一个类应该有且只有一个去改变他的理由，这意味着一个类应该只有一项工作。

```
public class AreaCalculator
{
    private float result;

    public float calculateArea(Shape s)
    {
        //calculates the area for a given shape, store in result
    }

    public String printAreaAccurateToOneDecimalPlace()
    {
        //prints result accurate to one decimal place
    }
}
```

减小一个类的 dependency

S.O.L.I.D原则

- Open close principle 开放封闭原则

对象或实体应该对扩展开放，对修改封闭 (Open to extension, close to modification)。

```
public class AreaCalculator
{

    public float calculateArea(Triangle t)
    {
        //calculates the area for triangle
    }

    public float calculateArea(Rectangle r)
    {
        //calculates the area for rectangle
    }
}
```

扩展开放：随着需求的增加，
设计也要很好的 handle

可以用一个 interface
有更多需求的时候可以 implement 这个 interface

interface 是一份合同
要履行的义务就是把里面定义的所有的函数要 implement 出来

可以用很多 interface，只能 extend 一个父类

S.O.L.I.D原则

- Liskov substitution principle 里氏替换原则

任何一个子类或派生类应该可以替换它们的基类或父类

```
public class Shape
{
    abstract public float calculateVolumn();
    abstract public float calculateArea();
}

public class Rectangle extends Shape
{
    //...
}

public class Cube extends Shape
{
    //...
}
```


S.O.L.I.D原则

- Interface segregation principle 接口分离原则

不应该强迫一个类实现它用不上的接口

```
public interface Shape
{
    public float calculateVolumn();
    public float calculateArea();
}

public class Rectangle implements Shape
{
    //...
}

public class Cube implements Shape
{
    //...
}
```


S.O.L.I.D原则

- Dependency inversion principle 依赖反转原则

抽象不应该依赖于具体实现，具体实现应该依赖于抽象

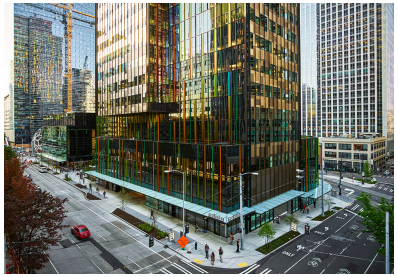
```
public class AreaCalculator
{

    public String shape_string;
    public Shape shape;

    public AreaCalculator()
    {
        if(shape_string.equals("Triangle"))
        {
            shape = new Triangle();
        }
        else if(shape_string.equals("Rectangle"))
        {
            shape = new Rectangle();
        }
    }

    public float area()
    {
        return shape.area();
    }
}
```

high level 的实体
不应该依赖于 low level的实体

```
public class AreaCalculator
{

    public float calculateArea(ShapeInterface s)
    {
        //calculates the area for triangle
    }
}

interface ShapeInterface
{
    public float area();
}

public class Rectangle implements ShapeInterface
{
    private float length;
    private float width;

    public float area()
    {
        return length * width;
    }
}

public class Triangle implements ShapeInterface
{
    private float height;
    private float width;

    public float area()
    {
        return (height * width) / 2;
    }
}
```


Elevator

- Can you design an elevator system for this building?



奔雷手 - 5C解题法

- Clarify
- Core objects
- Cases
- Classes
- Correctness

奔雷手 - 5C解题法

Clarify
说人话：通过和面试官交流，去除题目中的歧义，确定答题范围
争取问出隐藏信息，自己掌握大概的框架

Core objects
说人话：确定题目所涉及的类，以及类之间的映射关系

Cases
说人话：确定题目中所需要实现的场景和功能

Classes
说人话：通过类图的方式，具体填充题目中涉及的类

Correctness
说人话：检查自己的设计，是否满足关键点

Clarify

Example: Glass of water ?

Clarify

- What
- How
- Who

Clarify

- What

针对题目中的关键字来提问，帮助自己更好的确定答题范围。

*大多数的关键字为名词，通过名词的属性来考虑

Clarify

关键字1：Elevator

属性？

Clarify

关键字1：Elevator

- 可能需要考虑获取每辆电梯的目前重量

问重量，而不是问能装多少人

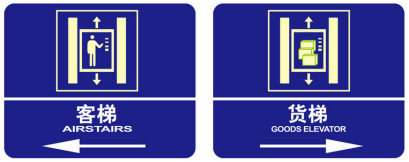
Clarify

关键字1：Elevator

- 没有电梯厢
- 每层楼之间不同

Clarify

关键字1：Elevator



- 是否需要设计两种类，如果需要它们之间是什么关系？
- 客梯和货梯有什么区别？

Clarify

关键字1：Elevator

针对本题：所有电梯厢均为相同规格

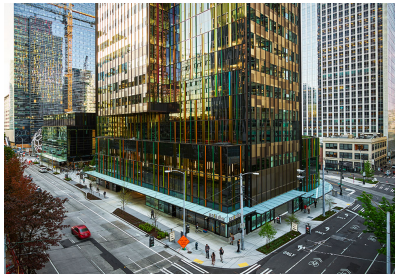
Clarify

关键字2：Building

属性？

Clarify

关键字2：Building

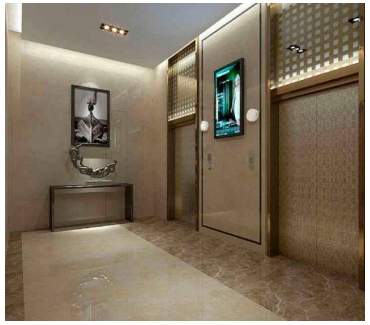


楼有多大/楼有多高/楼内能容纳多少人？

- 通用属性，对于题目帮助不大

Clarify

关键字2：Building



是否有多处能搭乘的电梯口？

- 当收到一个搭乘电梯的请求时，有多少电梯能够响应？

Clarify

关键字2：Building

针对本题：每层仅一处能搭乘，所有电梯均可响应

Clarify

- How

针对问题主题的规则来提问，帮助自己明确解题方向。

*此类问题没有标准答案，你可以提出一些解决方法，通过面试官的反应，选择一个你比较有信心（简单）的方案

Clarify

电梯有哪些规则？

Clarify

当按下按钮时，哪一台电梯会相应？

- 同方向 > 静止 > 反向
- 一半负责奇数楼层，一半负责偶数楼层
- ...

Clarify

当电梯在运行时，哪些按键可以响应？

- 是否能按下反向的楼层

Clarify

规则：

对于本题：同向 > 静止 > 反向，当运行时不能按下反向的楼层

信息：电梯至少需要三种状态，并且要知道当前在哪一层

Clarify

- Who

设计由人主导 VS. 设计由系统主导？

Clarify

- Who

设计由人主导 VS. 设计由系统主导？

Clarify

- Who

Optional, 通过思考题目当中是否有人的出现，来帮助确定解题范围

*一般可以考虑人的角色以及人的属性，看是否题目需要

Clarify

人物属性 ？

Clarify

电梯系统如何获取每位乘客的重量？

- Passenger class包含重量
- 电梯能够自动感应当前重量

Clarify

对于本题：

电梯能够获取当前重量

Core Object

- 什么是Core Object
- 为什么要定义Core Object？
- 如何定义Core Object？

Core Object

- 什么是Core Object

为了完成设计，需要哪些类？

Core Object

- 为什么要定义Core Object？

- 这是和面试官初步的纸面contract
- 承上启下，来自于Clarify的结果，成为Use case的依据
- 为画类图打下基础

Core Object

- 如何定义Core Object？

- 以一个Object作为基础，线性思考
- 确定Objects之间的映射关系

Core Object

- 如何定义Core Object？ 写在白板上

ElevatorSystem

Core Object

- 如何定义Core Object？

Request → ElevatorSystem

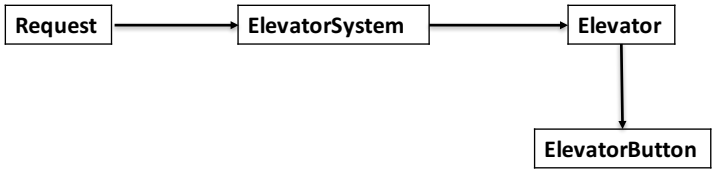
Core Object

- 如何定义Core Object？

Request → ElevatorSystem → Elevator

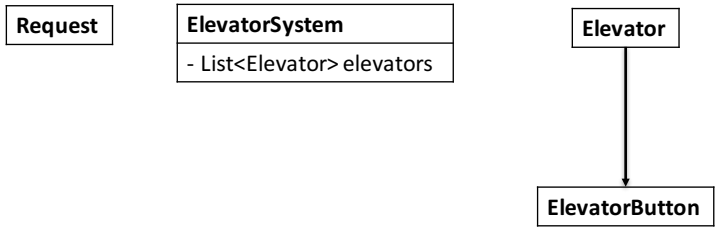
Core Object

- 如何定义Core Object ?



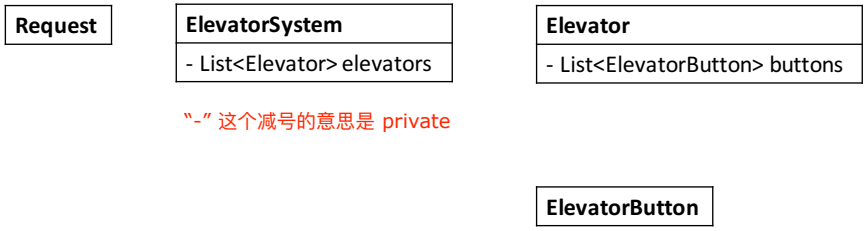
Core Object

- 如何定义Core Object ?



Core Object

- 如何定义Core Object ?



"-" 这个减号的意思是 private

Good Practice

- Access modifier 不同级别的 access level

- package
- public
- private
- protected

Good Practice

- package

如果什么都不声明，变量和函数都是package level visible的，在同一个package内的其他类都可以访问

Example:

一般不要使用默认，什么都不画
package level 的用途是方便用于 test

```
String input = "test";

void printInput()
{
    System.out.println(input);
}
```

在类图中，避免使用default的package level access

Good Practice

- public

如果声明为public，变量和函数都是public level visible的，任何其他的类都可以访问

Example:

```
public static void main(String[] arguments)
{
    //...
}
```

无论所有 package，都可以访问到

java 的 main 函数必须要 public
画类图 用“+”代表 public

在类图中，用”+”表示一个变量或者函数为public

Good Practice

- private

如果声明为private，变量和函数都是class level visible的，这是所有access modifier中限制最多的一个。仅有定义这些变量和函数的类自己可以访问。

private也是OOD当中实现封装的重要手段。

Example:

- private： class level, 用于封装，
可以只 expose 你想 expose 的部分

protected: class level + child of this class
实现继承的重要手段

```
public class AreaCalculator()
{
    private Logger log;
}
```

在类图中，用”-”表示一个变量或者函数为private

Good Practice

- protected

如果声明为protected，变量和函数在能被定义他们的类访问的基础上，还能够被该类的子类所访问。

protected也是OOD当中实现继承的重要手段。

Example:

```
class AudioPlayer
{
    protected Speaker speaker;
}

class StreamingAudioPlayer extends AudioPlayer
{
    public void openSpeaker()
    {
        speaker.open();
    }
}
```

在类图中，用”#”表示一个变量或者函数为protected

Cases

九章算法

- 什么是Use case ？
- 为什么要写Use cases ？
- 如何写Use cases ？

Cases

九章算法

- 什么是Use case ？

在你设计的系统中，需要支持哪些功能？

Cases

九章算法

- 为什么要写Use cases ？

- 这是你和面试官白纸黑字达成的第二份共识，把你将要实现的功能列在白板上
- 帮助你在解题过程中，理清条例，一个一个Case实现
- 作为检查的标准

Cases

九章算法

- 怎么写Use cases ？

- 利用定义的Core Object, 列举出每个Object对应产生的use case.
- 每个use case只需要先用一句简单的话来描述即可

Cases

- ElevatorSystem

- Handle request

Cases

- Elevator

- Take external request
- Take internal request
- Open gate
- Close gate
- Check weight

每个 class 可以拥有多个函数，
都是跟电梯相关的功能，

所以除了 check weight 可以使用一个外面的 sensor，
其他都是电梯的功能。

What about single responsibility principle?

Cases

- ElevatorButton

- Press button

Class

- 什么是类图？
- 为什么要画类图？
- 怎么画类图？

In software engineering,
a class diagram in the Unified Modeling Language (UML)
is a type of static structure diagram that describes the structure of a system

by showing the system's classes, their attributes, operations (or methods),
and the relationships among objects.

Class

- Class diagram (类图)

Class Name
Attributes
Functions

Class

- 为什么要画类图？

- 可交付，Minimal Viable Product
- 节省时间，不容易在Coding上挣扎
- 建立在Use case上，和之前的步骤层层递进，条例清晰，便于交流和修改
- 如果时间允许/面试官要求，便于转化成Code

Class

- 怎么画类图？

- 遍历你所列出的use cases
- 对于每一个use case，更加详细的描述这个use case在做什么事情（例如：take external request -> ElevatorSystem takes an external request, and decide to push this request to an appropriate elevator）
- 针对这个描述，在已有的Core objects里填充进所需要的信息

Class

Request

ElevatorSystem
- List<Elevator> elevators

Elevator
- List<ElevatorButton> buttons

ElevatorButton

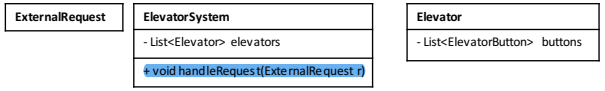
Use cases
Handle request
Take external request
Take internal request
Open gate
Close gate
Check weight
Press button

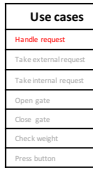
Class

- Use case: Handle request

ElevatorSystem takes an **external request**, and decide to push this request to an appropriate **elevator**

Class





Good Practice

- 如何知道一个函数，是否成功完成任务？

地下一层电梯关闭，这时有人在地下一层按了向上的按钮，会发生什么？

Good Practice

- 如何知道一个函数，是否成功完成任务？

- Use boolean instead of void
成功的话返回true, 否则返回false

缺点：一元返回值，只知道对错，并不知道错的原因

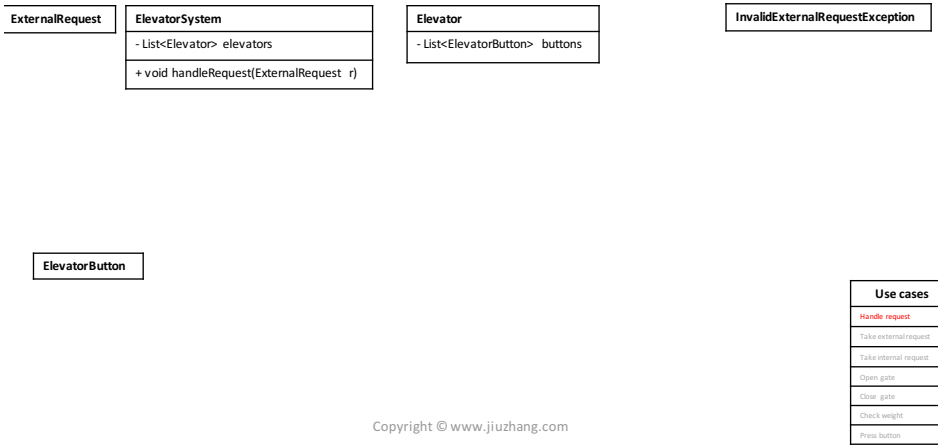
- 如何知道是什么地方出错？

Good Practice

- 如何知道一个函数，是否成功完成任务？

- Use exceptions　throw 异常， 为了记录，知道哪里有问题

Class

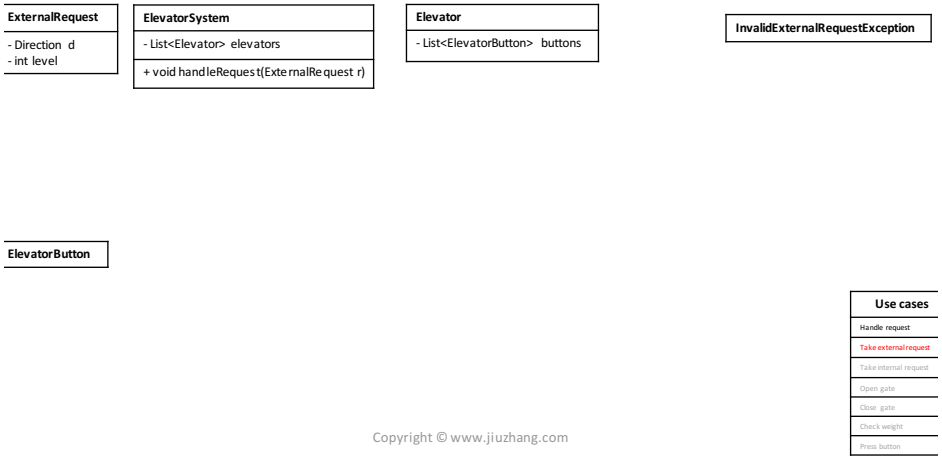


Class

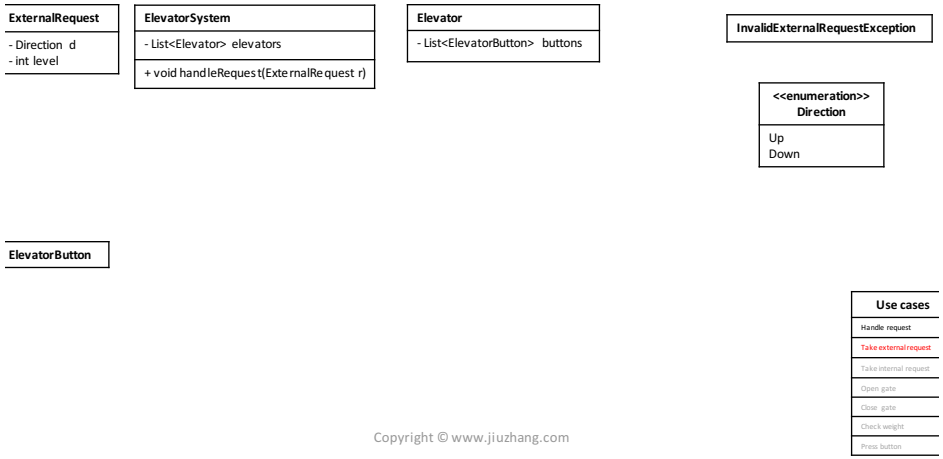
- Use case: Take external request

An **elevator** takes an external **request**, inserts in its stop list.

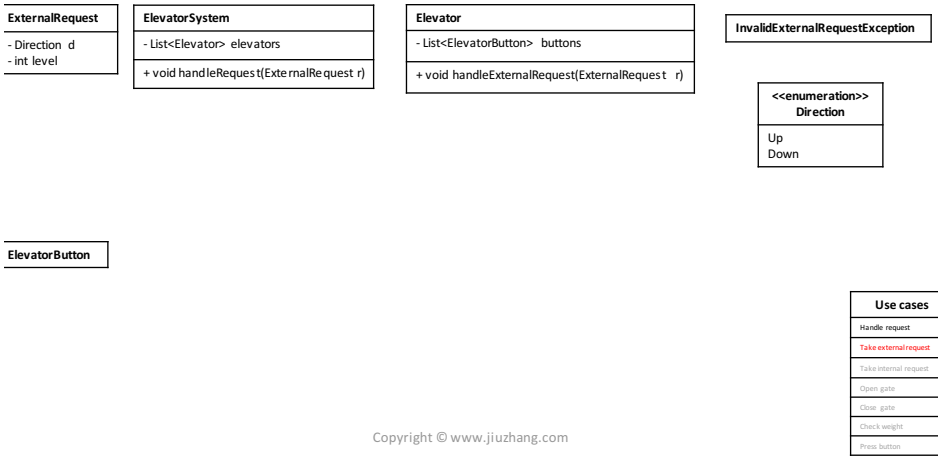
Class



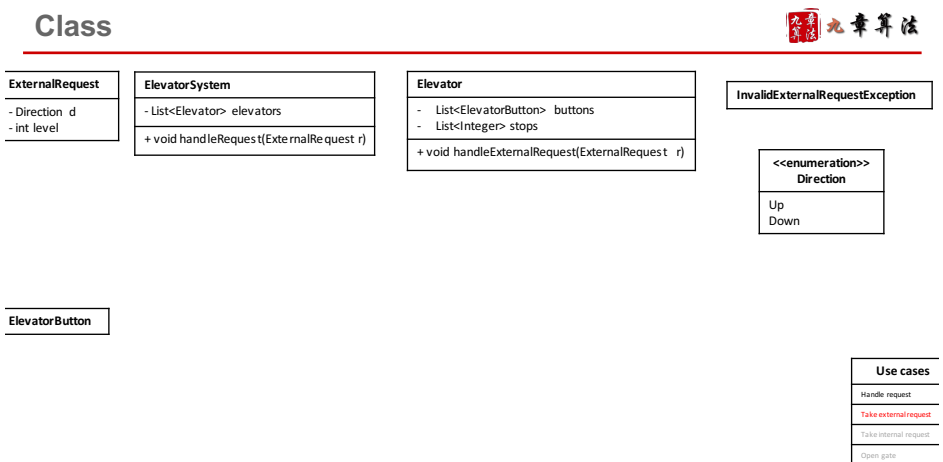
Class



Class



Class



Challenge

- 如果电梯目前在1L，有人按下了5L向上，之后又有人按下了3L向上，电梯会怎样行动？

stops will be {5,3}

Expected is: {3,5}

Challenge

- 如果电梯目前在1L，有人按下了5L向上，之后又有人按下了3L向上，电梯会怎样行动？

stops will be {5,3}

Expected is: {3,5}

Solution1: sort stops every time we add to it.

Challenge

- 如果电梯目前在1L，有人按下了5L向上，之后又有人按下了3L向上，电梯会怎样行动？

stops will be {5,3}

Expected is: {3,5}

Solution2: use priority queue instead of list

Challenge

- 如果电梯目前在1L，有人按下了5L向上，之后又有人按下了3L向上，紧接着这台电梯又被分配了一个2L向下的request。这台电梯会如何行动？

stops will be {2，3，5}

Expected is: {3，5，2}

Challenge

- 如果电梯目前在1L，有人按下了5L向上，之后又有人按下了3L向上，紧接着这台电梯又被分配了一个2L向下的request。这台电梯会如何行动？

stops will be {2，3，5}

Expected is: {3，5，2}

Solution: keep 2 lists for different direction

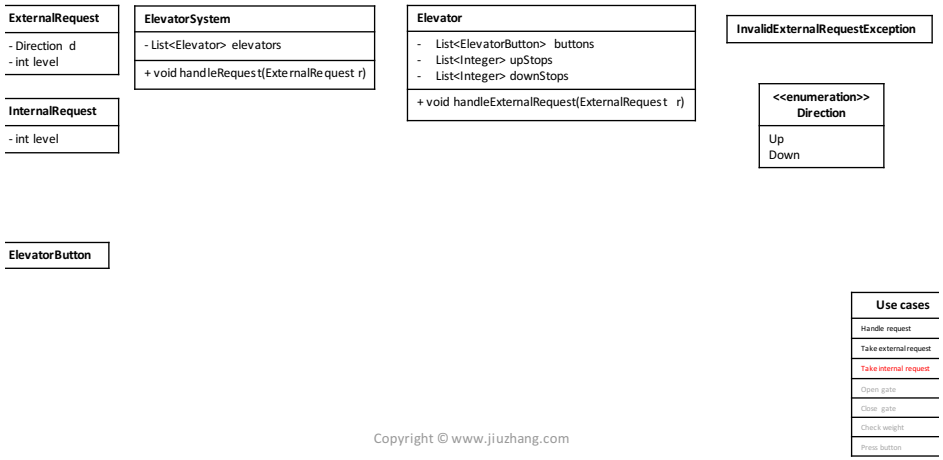
Class

Class

- Use case: Take internal request

An **elevator** takes an internal **request**, determine if it's valid, inserts in its stop list.

Class



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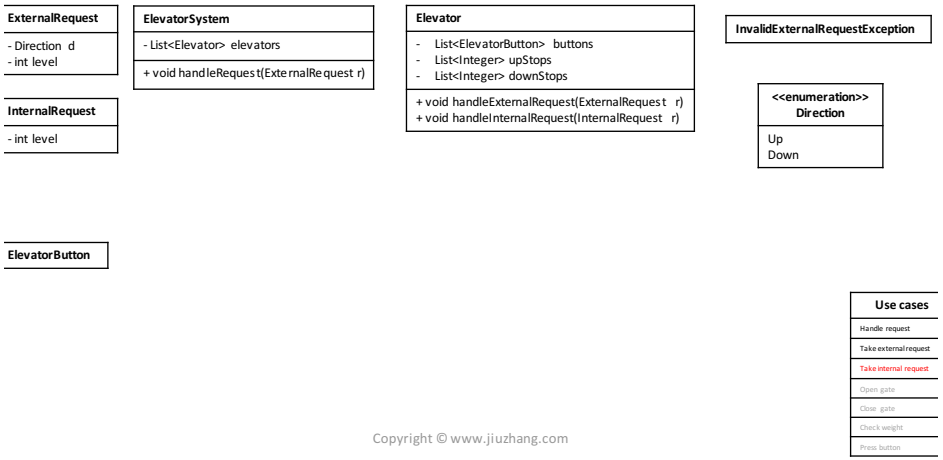

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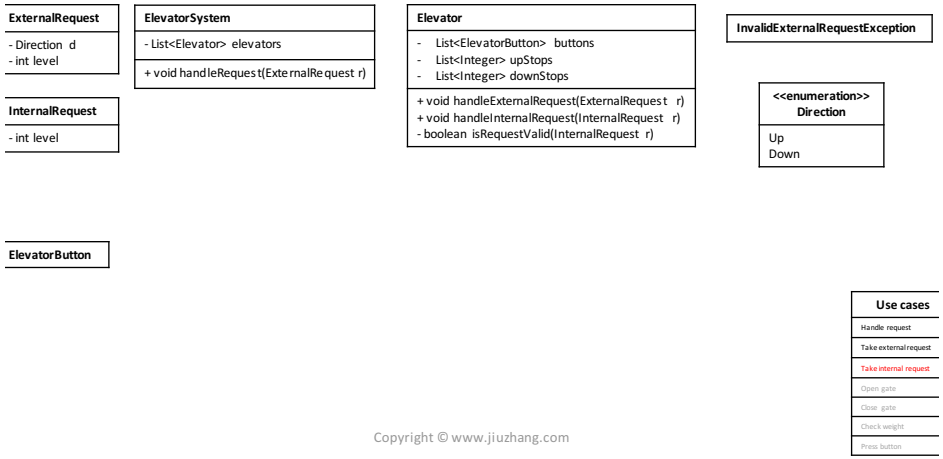

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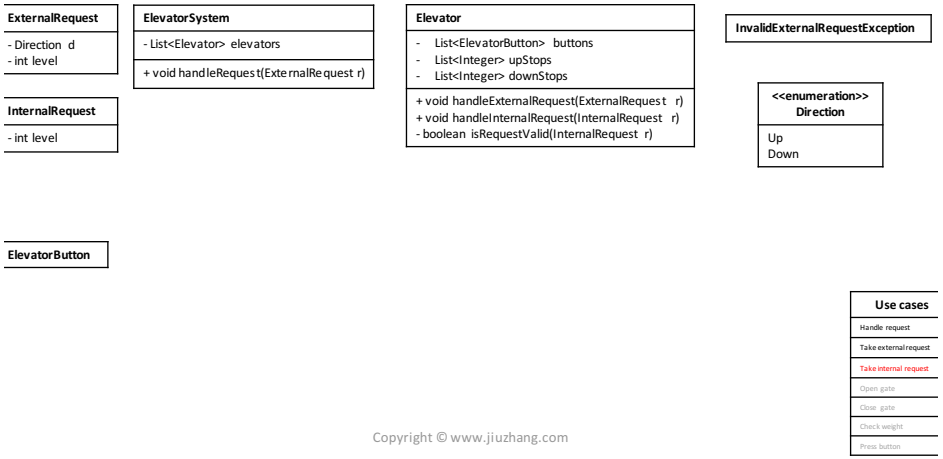


Challenge

- 如何判断一个Internal request 是否为Valid?

Challenge

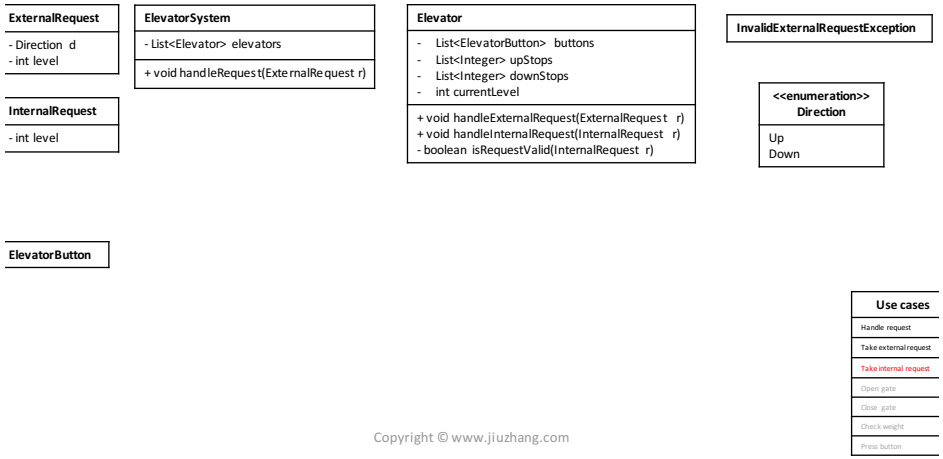
- 如何判断一个Internal request 是否为Valid?

Solution:

If elevator **going up**
    requested level lower than **current level**
        invalid

If elevator **going down**
    requested level higher than **current level**
        invalid

Class



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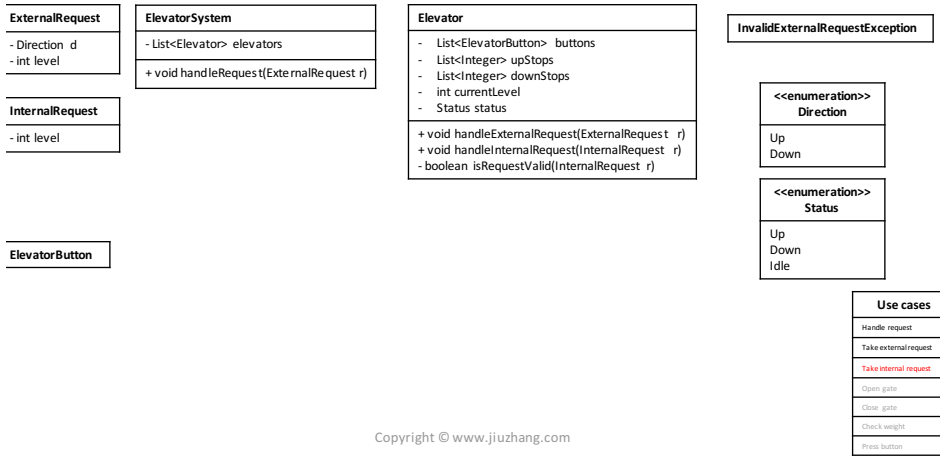
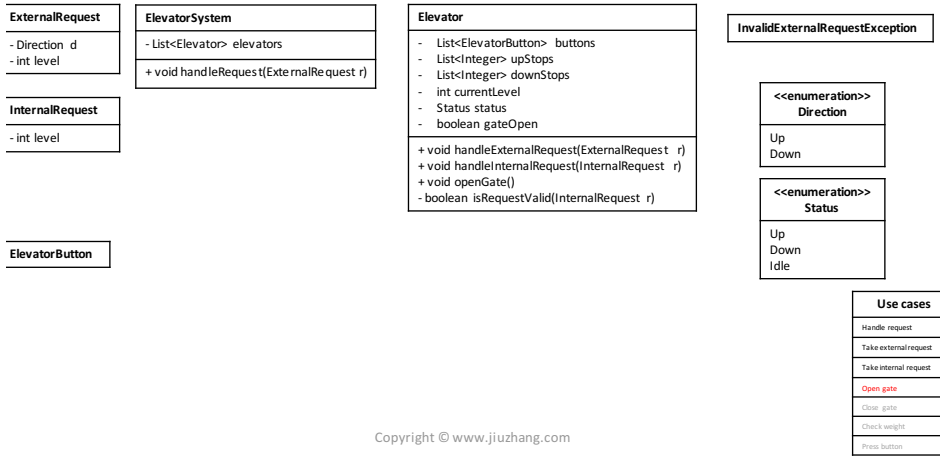


Class

- Use case: Open gate

An **elevator** reaches the destination level, open gate

Class



Class

- Use case: Close gate

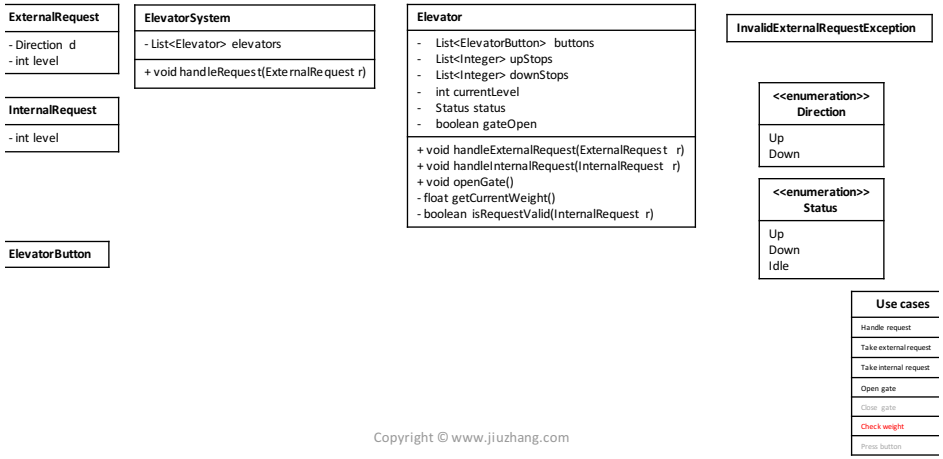
An **elevator**
checks if overweight;
close the door;
then check stops corresponds to current status;
if no stops left, check the reserve direction stops;
change status to reserve direction or idle.

Class

- Use case: check weight

An **elevator** checks its **current weight** and compare with **limit** to see if overweight

Class



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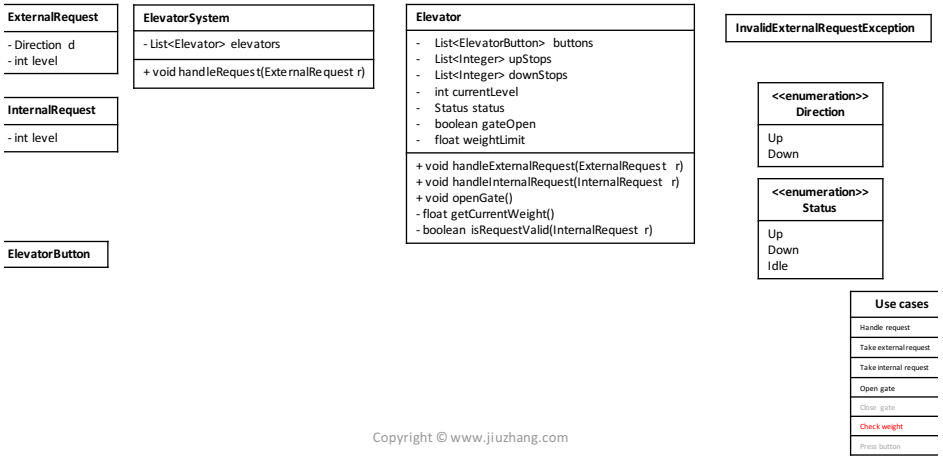

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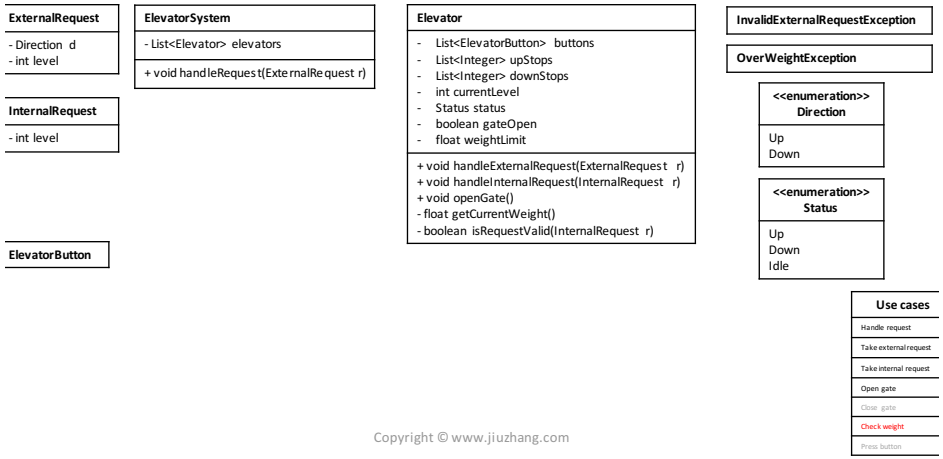

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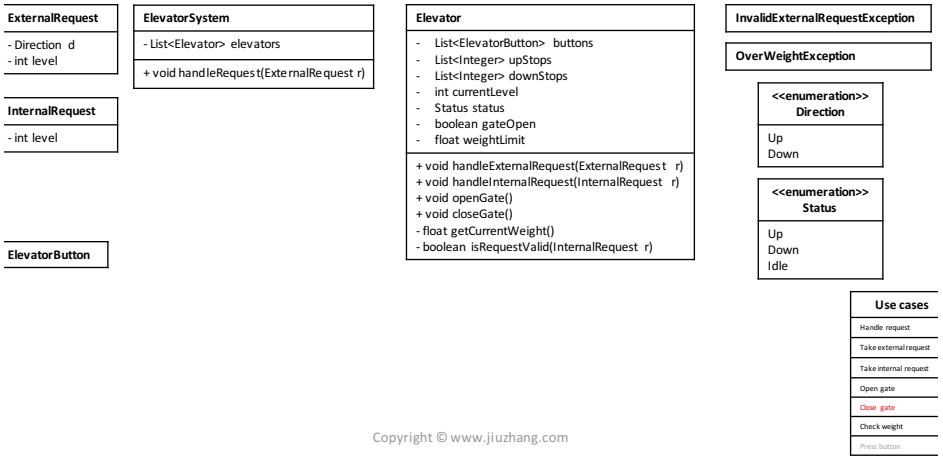
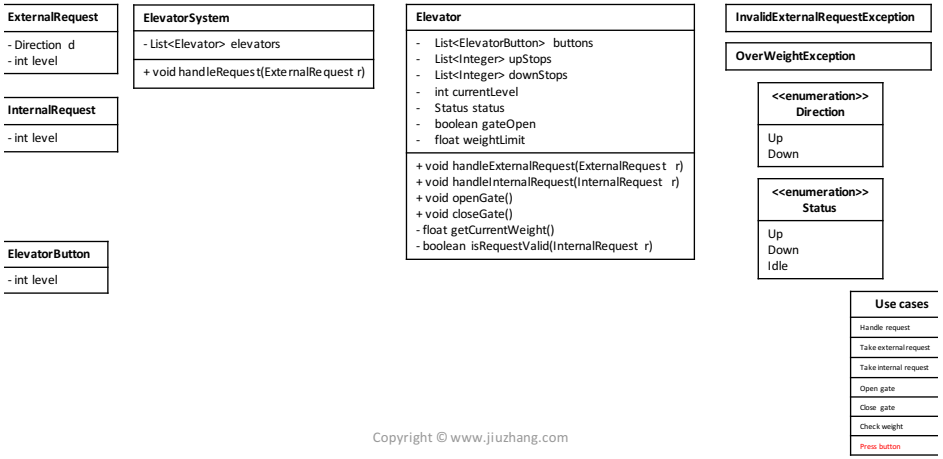


Class

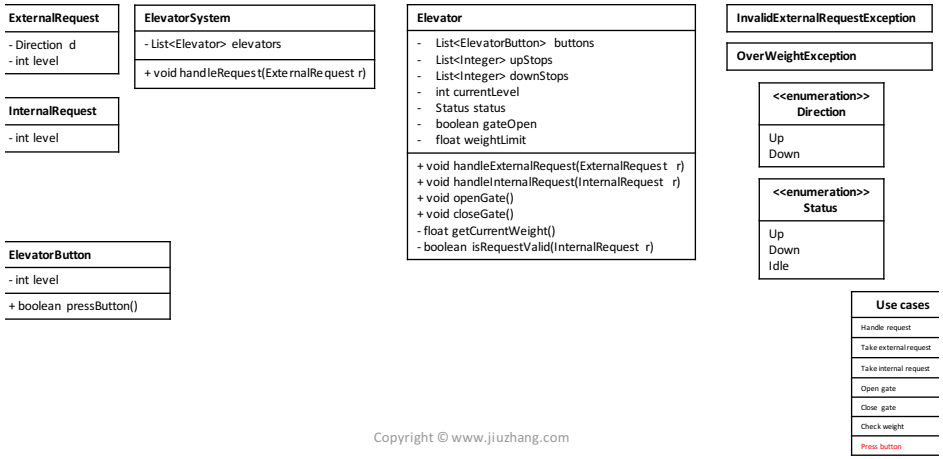
- Use case: press button

A **button** inside elevator is pressed, will generate an **internal request** and send to the **elevator**.

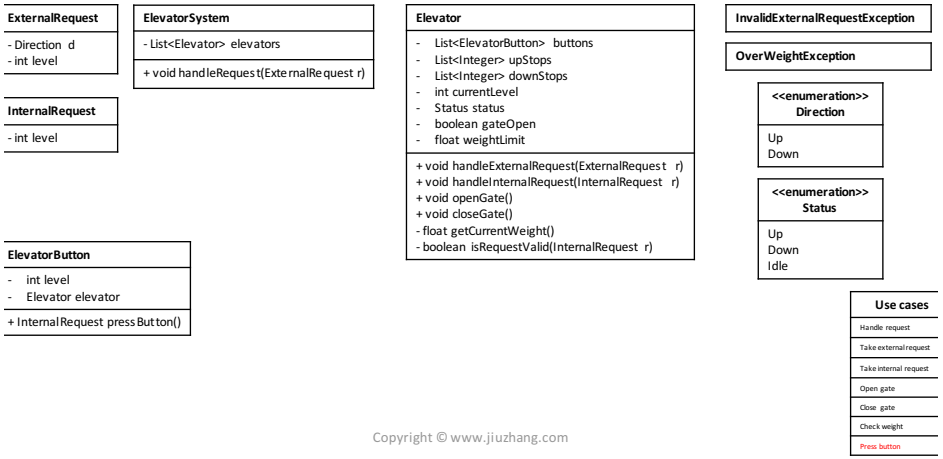
Class



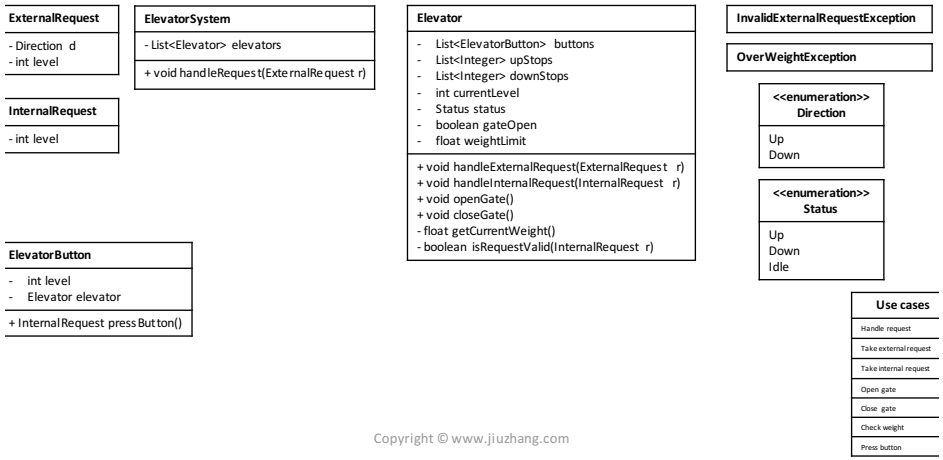
Class



Class



Class – Final view



Correctness

- 从以下几方面检查：

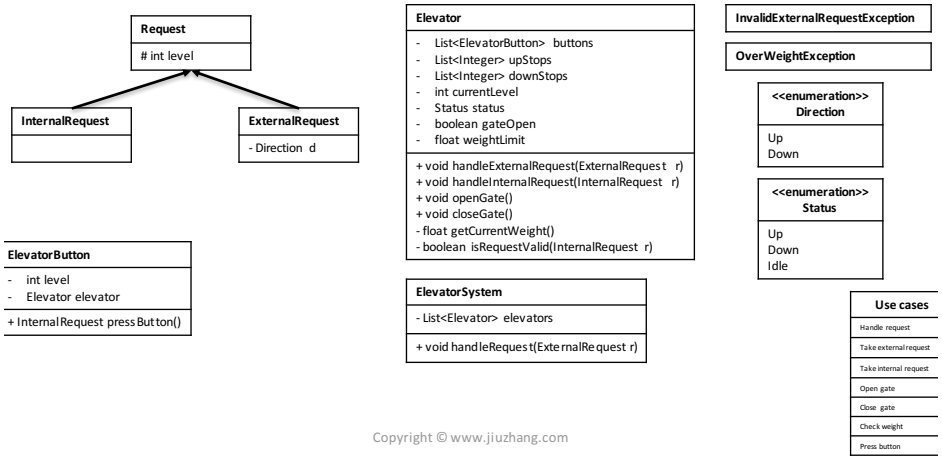
- Validate use cases (检查是否支持所有的use case)
- Follow good practice (面试当中的加分项，展现一个程序员的经验)
- S.O.L.I.D
- Design pattern

Good Practice

- 继承

检查你的设计中，是否有重复的类，可以采用继承的方式来表现

Good Practice



Challenge

- How do you handle an external request?
- What if I want to apply different ways to handle external requests during different time of a day?
- Can you implement it in code?

Challenge

- How do you handle an external request?

如我们最早和面试官讨论的结果：

同方向 > 静止 > 反向

Challenge

- What if I want to apply different ways to handle external requests during different time of a day?

Challenge

- What if I want to apply different ways to handle external requests during different time of a day?
- Solution 1: if - else

```
public void handleRequest(ExternalRequest r)
{
    if(time == TIME.PEAK)
    {
        // use peak hour handler
    }

    else if(time == TIME.NORMAL)
    {
        // use normal hour handler
    }
}
```


Challenge

- What if I want to apply different ways to handle external requests during different time of a day?

Solution 2: Strategy design pattern

1. 封装了多种算法/策略
   ※ 方便其他系统使用
   ※ 方便找到问题，修改
2. 使得算法/策略之间能够互相替换

Context

interface
Strategy

strategyA

strategyB

Recap

- 什么是OOD
- SOLID原则
- 5C 解题法
- Good practice: Access modifier
- Good practice: Exception
- Design pattern: Strategy

第2章 管理类面向对象设计 OOD for Management System

本节大纲

- 管理类 OOD 面试题型特点分析
- 实战OOD面试真题：
  - 停车场问题 Parking lot
  - 餐厅管理问题 Restaurant
- 设计模式讲解 Design Pattern: Singleton

第3章 预定类面向对象设计 OOD for Reservation System

本节大纲

- 预定类面试题型特点分析
- 实战面试真题：
  - 酒店预订系统设计 Hotel Reservation
  - 航空机票预订系统设计 Airline Ticket Reservation

第4章 实物类面向对象设计 OOD for Real Life Object

本节大纲

- 实物类面试题型特点分析
- 实战面试真题：
  - Vending machine
  - Juke box
- 设计模式讲解 Design Pattern: Factory
- 设计模式讲解 Design Pattern: Adaptor

第5章 游戏棋牌类面向对象设计 OOD for Games

本节大纲

- 棋牌游戏类面试题型特点分析
- 棋牌游戏类面试题特殊技巧讲解
- 实战面试真题：
  - Black Jack
  - Chinese chess
- 课程总结及面试技巧点拨