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- 实物类OOD题型
- 实物类OOD解题思路
- Vending machine
- Coffee maker
- Kindle

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实物类OOD题型

- Vending machine
- Jukebox
- CD Player
- Coffee maker
- Kindle

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实物类OOD题型

- 频率：中高

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实物类OOD题型

- 频率：中高
- 难度：中低

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- 考虑对于实物的输入输出

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例子：Coffee maker

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例子：Coffee maker

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实物类OOD解题技巧

- Design pattern的运用

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实物类OOD解题技巧

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- Design pattern的运用

State pattern Decorate pattern Factory pattern

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Vending Machine

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- Can you design a vending machine?

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Clarify

- What
- How

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- What

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关键字： Vending machine, Payment, Item

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厂家，重量，颜色...

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Clarify

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厂家，重量，颜色...

VendingMachine
- String manufacture
+ String getManufacture()

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Clarify

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大小： Vending machine的大小是否有限制？

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What items does this vending machine sell?

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Clarify

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What items does this vending machine sell?

Naïve design approach: each item matches a class

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Clarify

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What to do when an item sold out?

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What to do when an item sold out?

Design: Might need to support refill use case

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Clarify

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What are the supported payment methods?

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Clarify

- Payment

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- Coin

- Paper money

- Credit card

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Clarify

- Payment

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- Coin/Paper money : 知道当前收了多少钱，找零

- Credit card: 直接当前Item的价格

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Clarify

- 对于本题：

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- 假设Vending machine的大小没有限制
- 假设目前只卖三种产品：Coke, Sprite和Mountain Dew
- 假设目前只接受硬币

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Clarify

- How

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Clarify

- How

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Clarify

- How to select item to purchase?

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Design: selectItem(?)

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Clarify

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- 假设输入一个input代表一种Item (e.g. A1 -> Coke)

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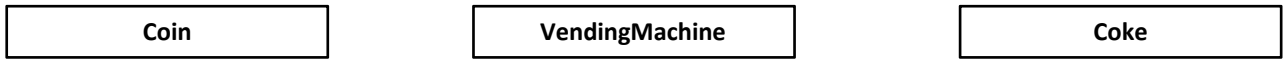

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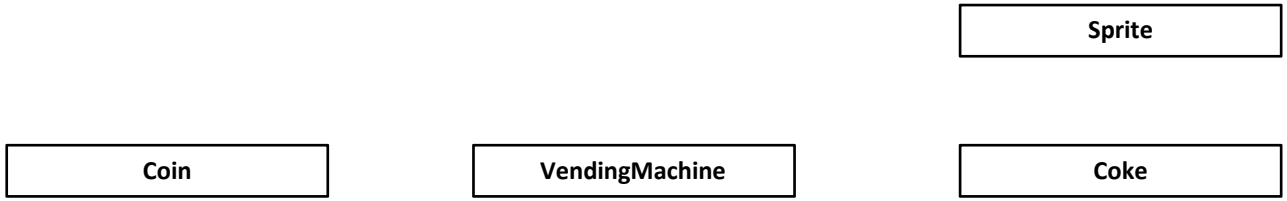

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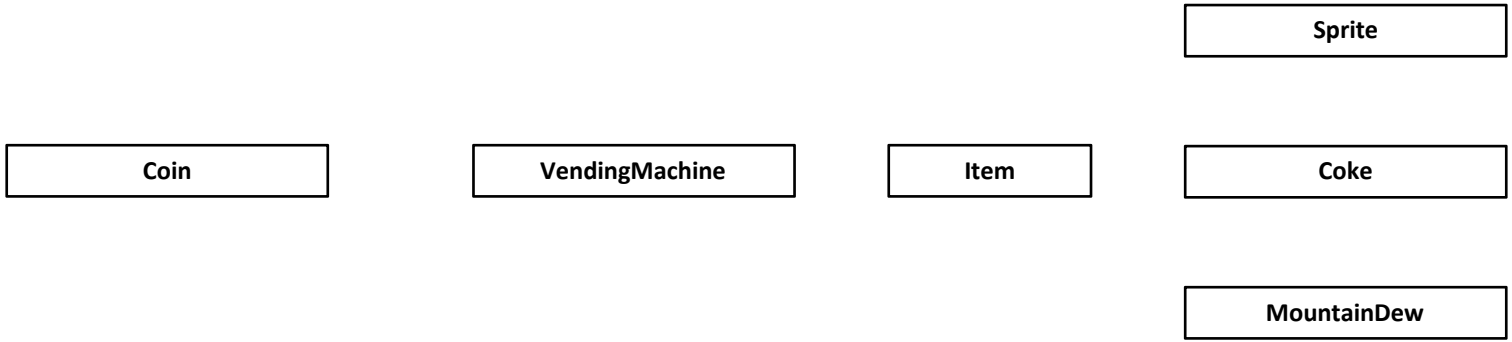

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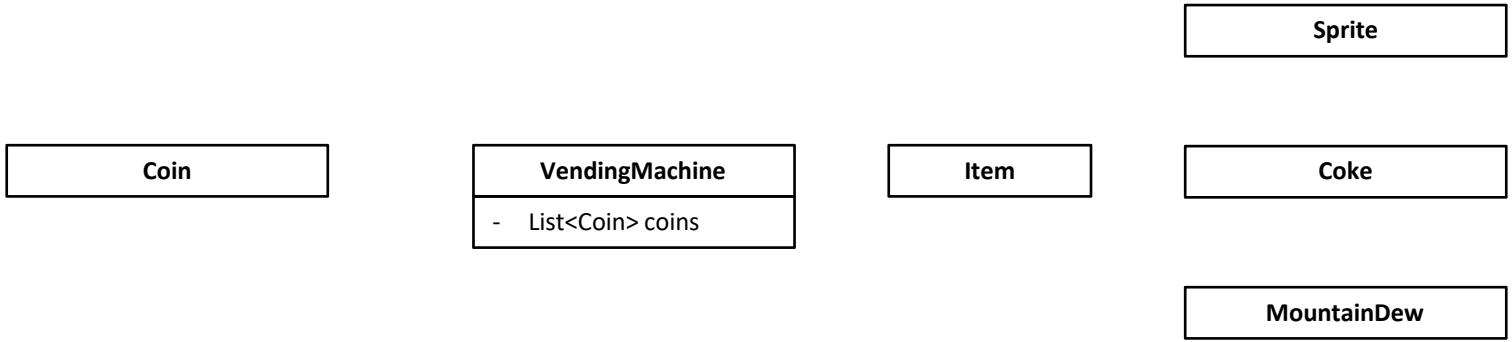

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Core Object

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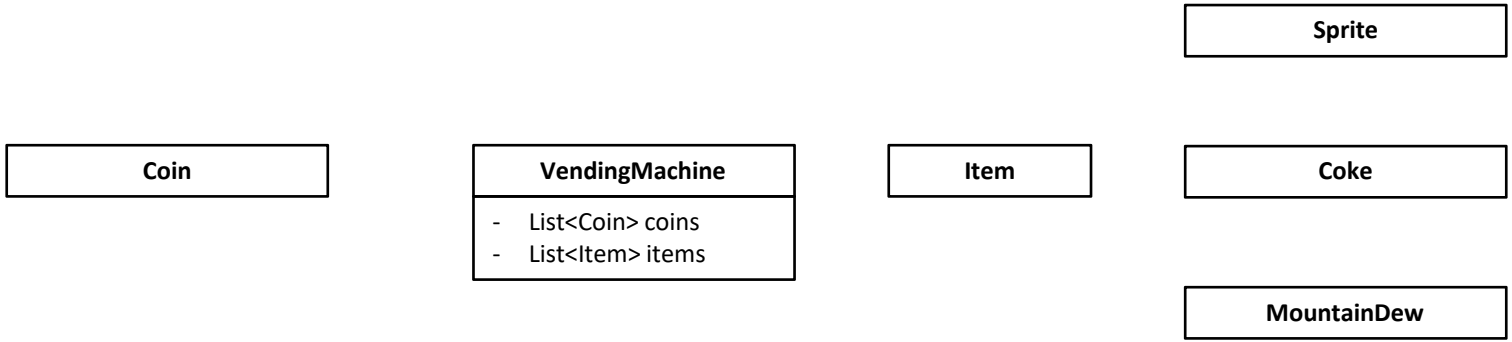

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Use cases

Vending machine

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Use cases

Vending machine:

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- Select item

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Use cases

Vending machine:

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- Select item
- Insert coin

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Use cases

Vending machine:

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- Select item
- Insert coin
- Execute transaction

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Use cases

Vending machine:

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- Select item
- Insert coin
- Execute transaction
- Cancel transaction

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Use cases

Vending machine:

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- Select item
- Insert coin
- Execute transaction
- Cancel transaction
- Refill items

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Classes

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VendingMachine

- List<Coin> coins
- List<Item> items

Coin

Item

Sprite

Coke

MountainDew

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Use cases

- Select item
- Insert coin
- Execute transaction
- Cancel transaction
- Refill items

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Classes

Use case: Select item

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- Vending machine takes an external input, shows the price of that item

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Classes

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VendingMachine

- List<Coin> coins
- List<Item> items

Coin

Item

Sprite

Coke

MountainDew

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Use cases

- Select item
- Insert coin
- Execute transaction
- Cancel transaction
- Refill items

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Classes

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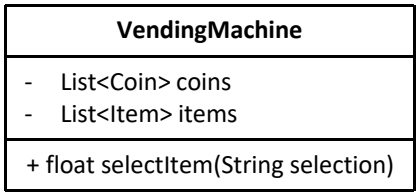

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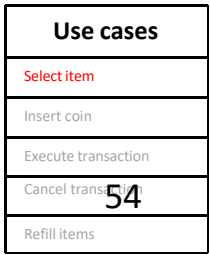

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Classes

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VendingMachine

- List<Coin> coins
- List<Item> items
- Map<String, Item> itemIdentifiers

+ float selectItem(String selection)

Coin

Item

Sprite

Coke

MountainDew

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Use cases

- Select item
- Insert coin
- Execute transaction
- Cancel transaction
- Refill items

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Challenge

"A1" ->

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Vending machine:

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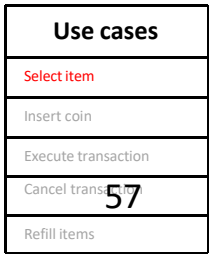

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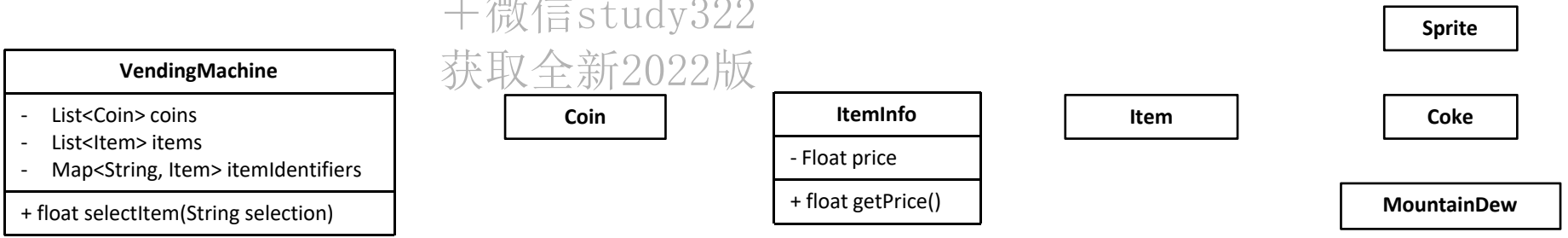

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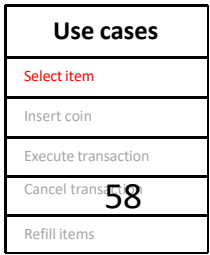

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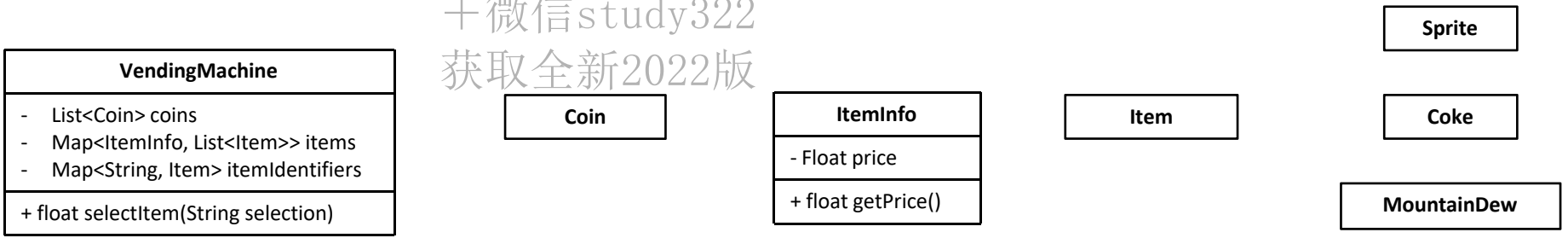

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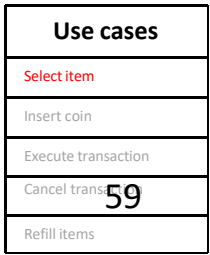

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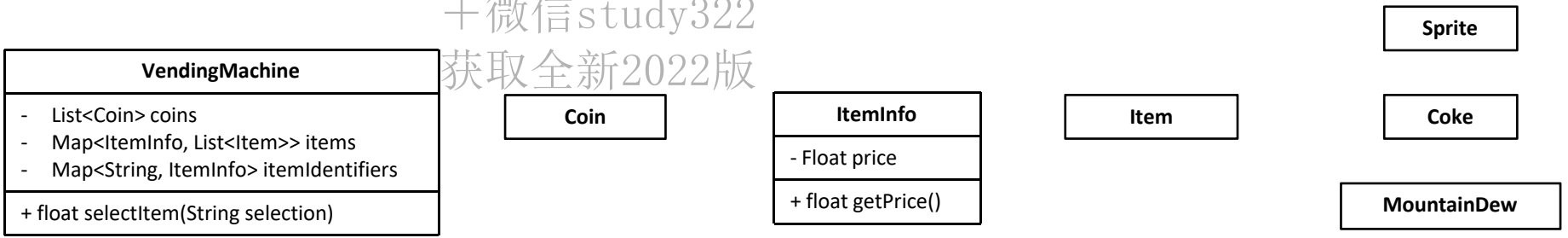

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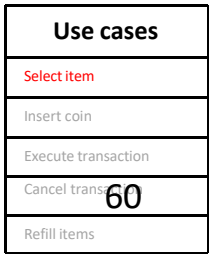

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Classes

Use case: Insert coin

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- Insert a list of coins into vending machine

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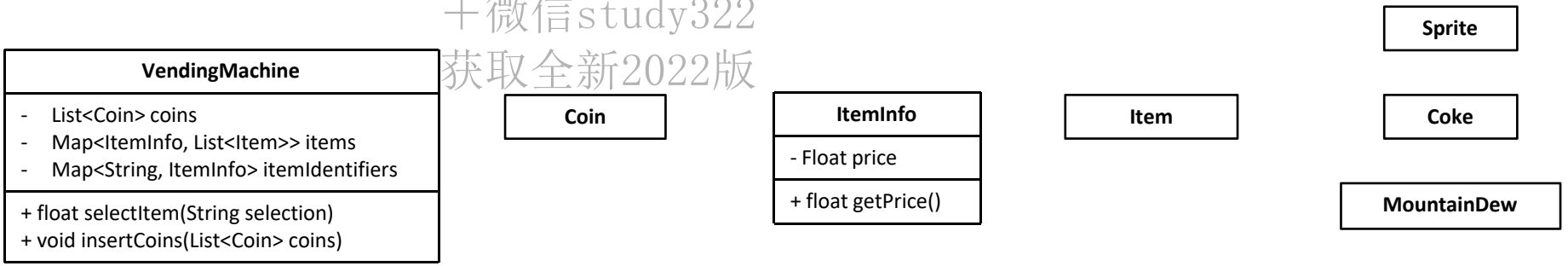

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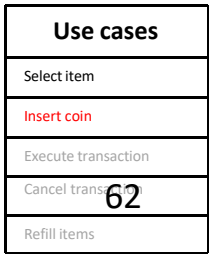

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Classes

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Use case: Execute transaction

- Get the current selected item
- Compare the item price and inserted coins
- If not enough money, throw an exception
- Else, return the item purchased
- Refund if any

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Use case: Execute transaction

- Get the current selected item

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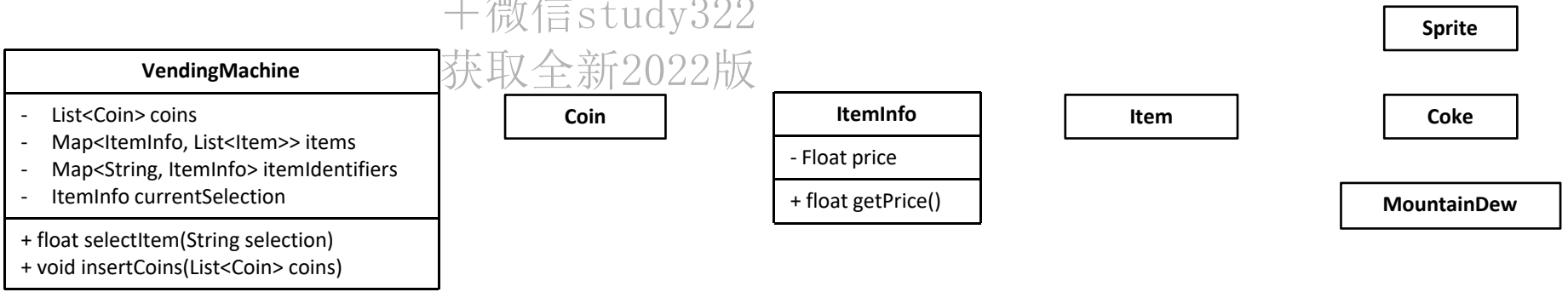

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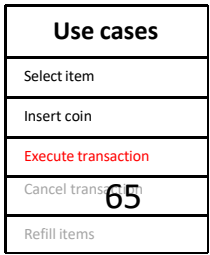

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Classes

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Use case: Execute transaction

- Get the current selected item
- Compare the item price and inserted coins

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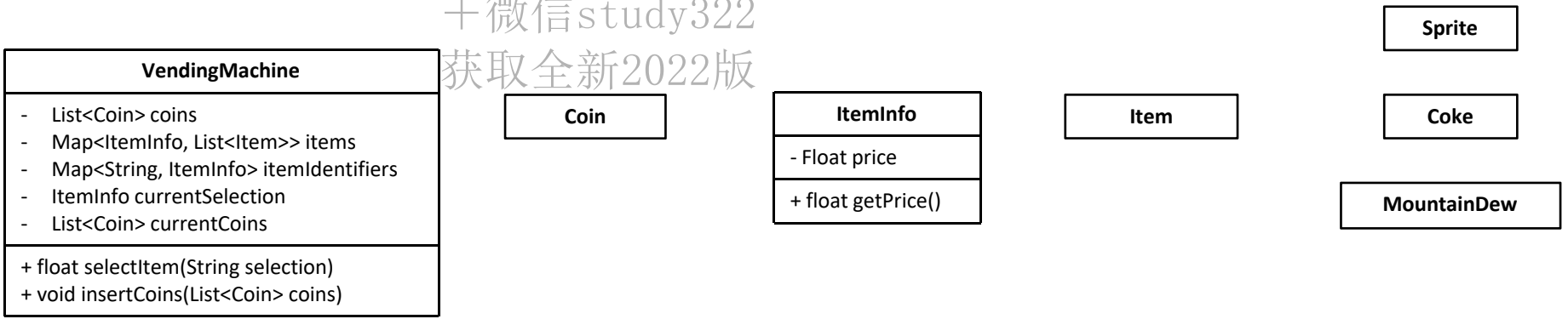

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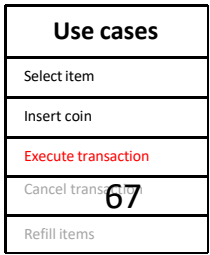

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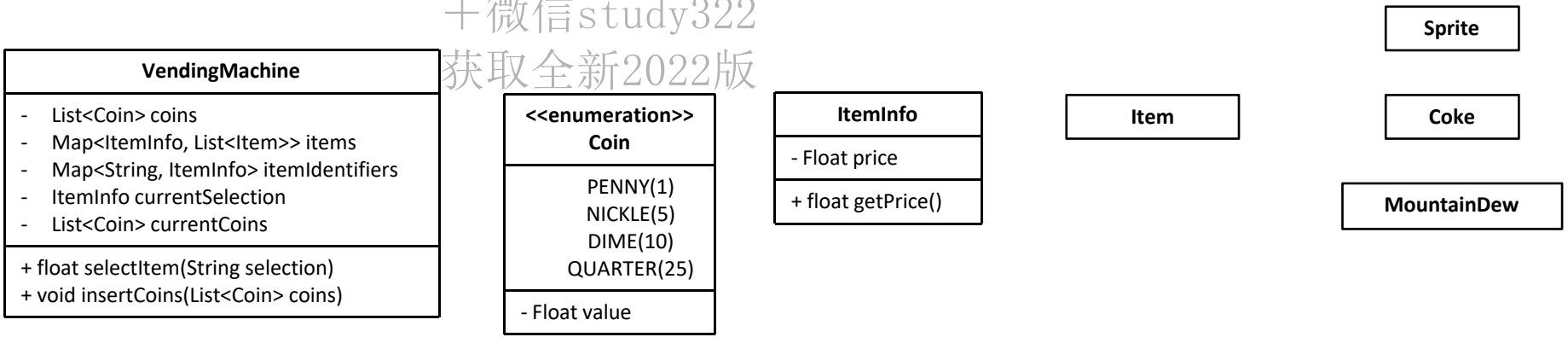

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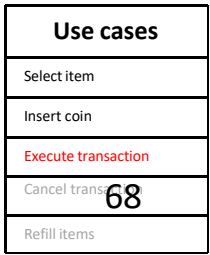

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Classes

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Use case: Execute transaction

- Get the current selected item
- Compare the item price and inserted coins
- If not enough money, throw an exception

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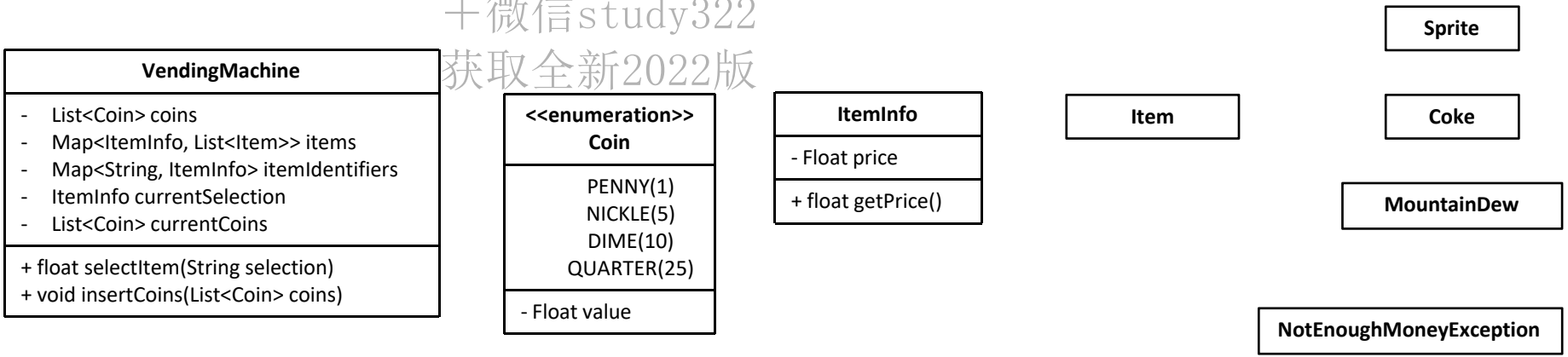

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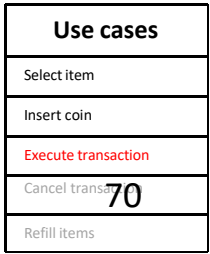

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Classes

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Use case: Execute transaction

- Get the current selected item
- Compare the item price and inserted coins
- If not enough money, throw an exception
- Else, return the item purchased

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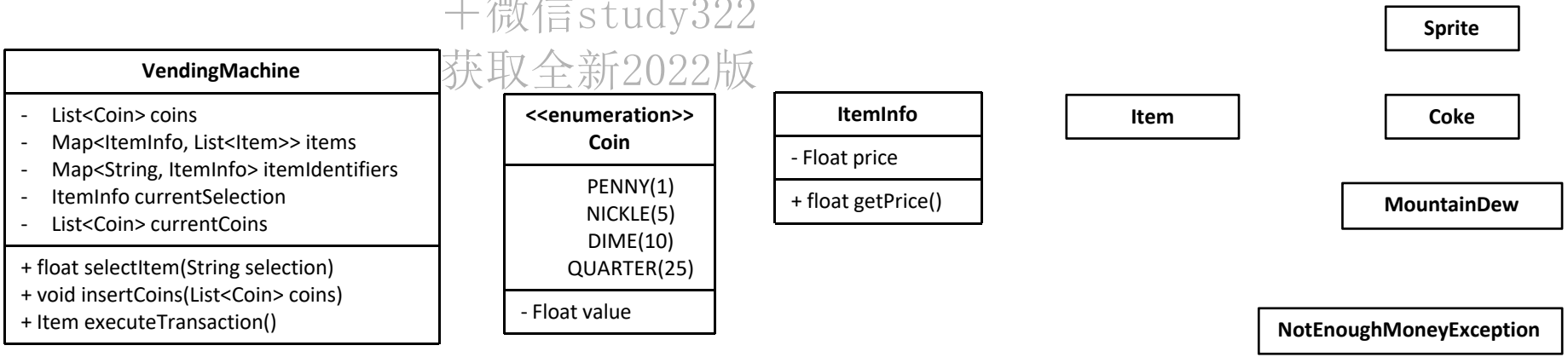

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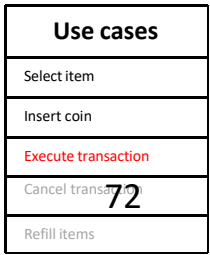

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Use case: Execute transaction

- Get the current selected item
- Compare the item price and inserted coins
- If not enough money, throw an exception
- Else, return the item purchased
- Refund if any

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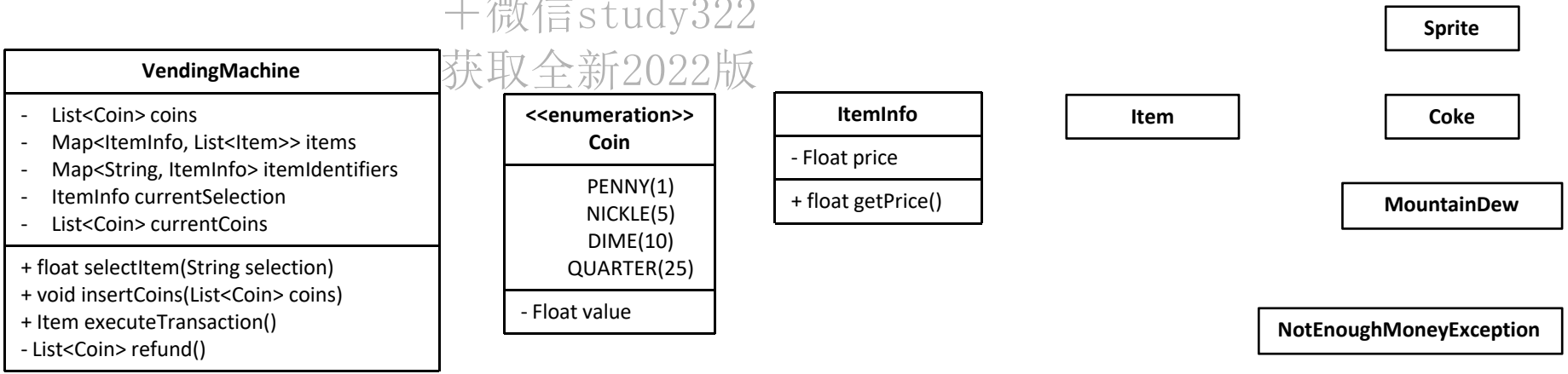

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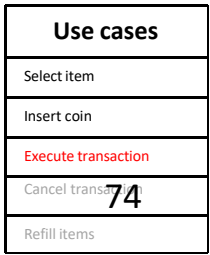

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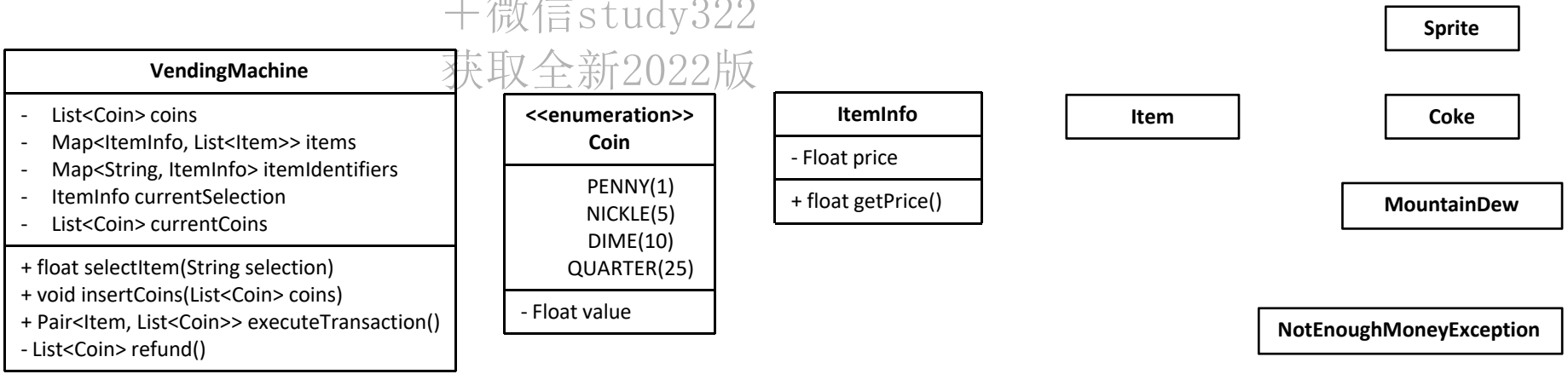

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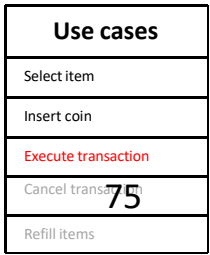

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Coin change

- http://www.cnblogs.com/grandyang/p/4840713.html

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Classes

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Use case: Cancel transaction

- Return the current coins that has been inserted

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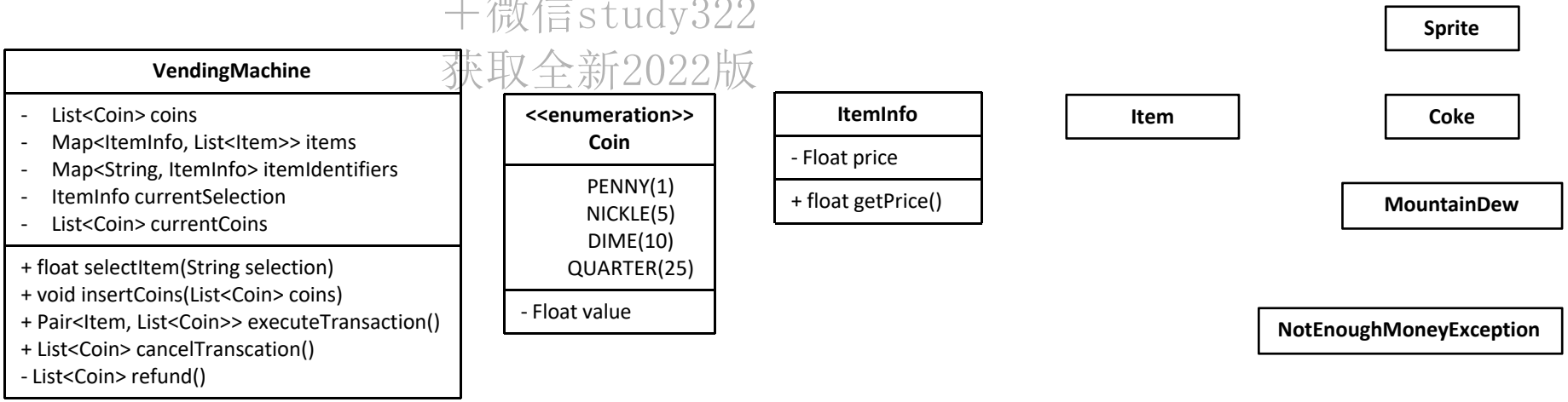

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Use cases
Select item
Insert coin
Execute transaction
Cancel transaction
Refill items

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Classes

Use case: Refill items

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- Refill items on top of current stock

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Classes

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VendingMachine

- List<Coin> coins
- Map<ItemInfo, List<Item>> items
- Map<String, ItemInfo> itemIdentifiers
- ItemInfo currentSelection
- List<Coin> currentCoins

+ float selectItem(String selection)
+ void insertCoins(List<Coin> coins)
+ Pair<Item, List<Coin>> executeTransaction()
+ List<Coin> cancelTranscation()
+ void refillItems(List<Item> items)
- List<Coin> refund()

<<enumeration>>
Coin

PENNY(1)
NICKLE(5)
DIME(10)
QUARTER(25)

- Float value

ItemInfo

- Float price

+ float getPrice()

Item

- ItemInfo info

Sprite

Coke

MountainDew

NotEnoughMoneyException

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Use cases

- Select item
- Insert coin
- Execute transaction
- Cancel transaction
- Refill items

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Classes

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VendingMachine

- List<Coin> coins
- Map<String, ItemInfo> itemIdentifiers
- ItemInfo currentSelection
- List<Coin> currentCoins
- Map<ItemInfo, List<Item>> stock

+ float selectItem(String selection)
+ void insertCoins(List<Coin> coins)
+ Pair<Item, List<Coin>> executeTransaction()
+ List<Coin> cancelTranscation()
+ void refillItems(List<Item> items)
- List<Coin> refund()

<<enumeration>>
Coin

PENNY(1)
NICKLE(5)
DIME(10)
QUARTER(25)

- Float value

ItemInfo

- Float price

+ float getPrice()

Item

- ItemInfo info

Sprite

Coke

MountainDew

NotEnoughMoneyException

NotEnoughItemException

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Use cases

- Select item
- Insert coin
- Execute transaction
- Cancel transaction
- Refill items

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Classes - Final view

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VendingMachine

- List<Coin> coins
- Map<String, ItemInfo> itemIdentifiers
- ItemInfo currentSelection
- List<Coin> currentCoins
- Map<ItemInfo, List<Item>> stock

+ float selectItem(String selection)
+ void insertCoins(List<Coin> coins)
+ Pair<Item, List<Coin>> executeTransaction()
+ List<Coin> cancelTranscation()
+ void refillItems(List<Item> items)
- List<Coin> refund()

<<enumeration>>
Coin

PENNY(1)
NICKLE(5)
DIME(10)
QUARTER(25)

- Float value

ItemInfo

- Float price

+ float getPrice()

Item

- ItemInfo info

Sprite

Coke

MountainDew

NotEnoughMoneyException

NotEnoughItemException

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Use cases

- Select item
- Insert coin
- Execute transaction
- Cancel transaction
- Refill items

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Good practice

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```
stock = new HashMap<ItemInfo, List<Item>>();
```

```
public void refillItem(List<Item> items)
{
    for(Item item : items)
    {
        ItemInfo info = item.getInfo();
        List<Item> itemsInStock = stock.get(info);
        itemsInStock.add(item);
        stock.put(info, itemsInStock);
    }
}
```

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Good practice

```
class Stock
{
    private HashMap<ItemInfo, List<Item>> stock;

    public void add(Item item)
    {
        ItemInfo info = item.getInfo();
        List<Item> itemsInStock = stock.get(info);
        itemsInStock.add(item);
        stock.put(info, itemsInStock);
    }
}

stock = new Stock();

public void refillItem(List<Item> items)
{
    for(Item item : items)
    {
        stock.add(item);
    }
}
```

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Good practice

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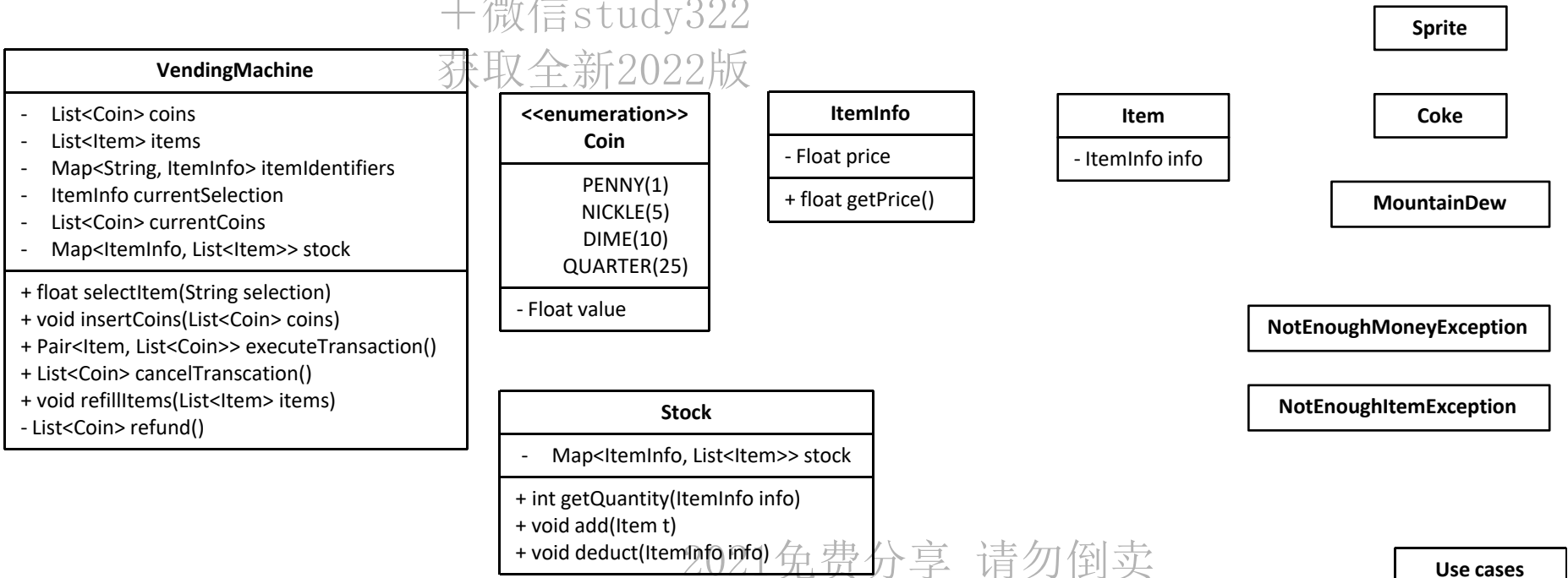

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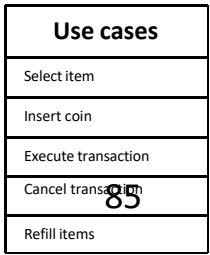

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Good practice

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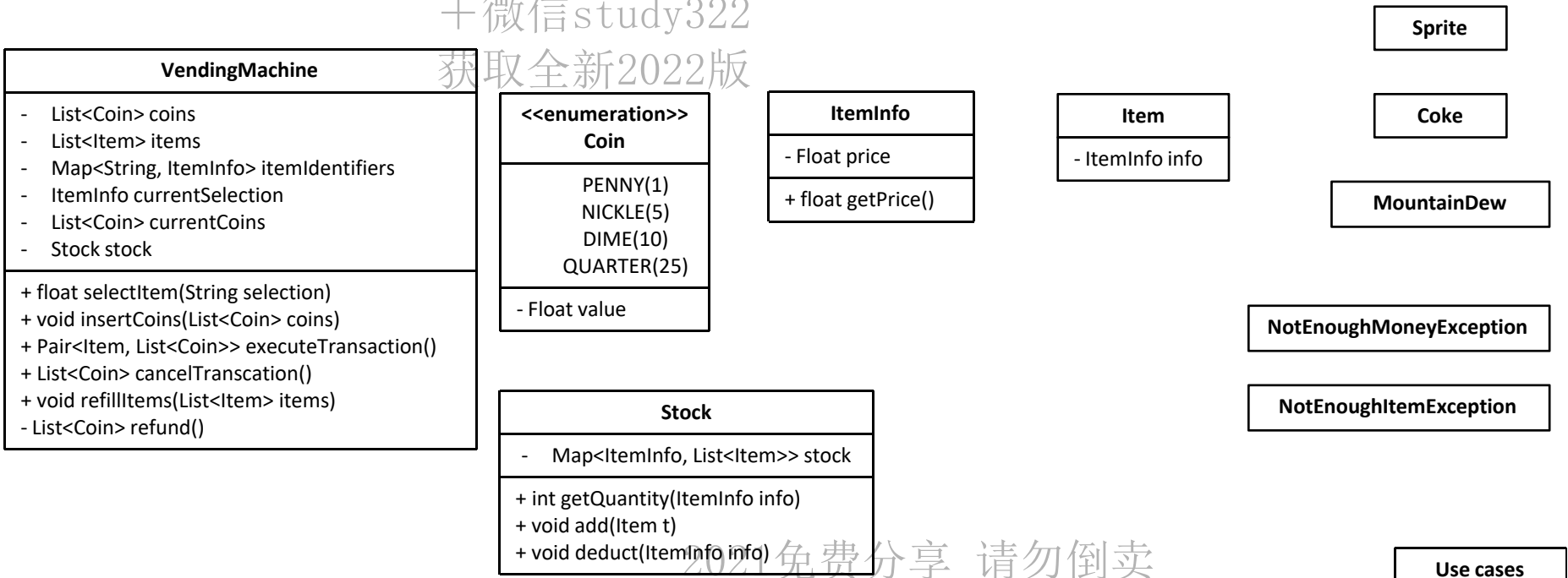

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Use cases
Select item
Insert coin
Execute transaction
Cancel transaction
Refill items

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Challenge

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- For these use cases:

- Select item
- Insert coin
- Execute transaction
- Cancel transaction

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Challenge

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- For these use cases:

- Select item
- Insert coin
- Execute transaction
- Cancel transaction

What will happen if some item has been selected?

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Challenge

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- For these use cases:

- Select item : throws a selections has already been made
- Insert coin
- Execute transaction
- Cancel transaction

What will happen if some item has been selected?

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Challenge

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- For these use cases:

- Select item : throws a selections has already been made
- Insert coin : update current inserted value
- Execute transaction
- Cancel transaction

What will happen if some item has been selected?

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Challenge

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- For these use cases:

- Select item : throws a selections has already been made
- Insert coin : update current inserted value
- Execute transaction : Get selected item if money is enough
- Cancel transaction

What will happen if some item has been selected?

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Challenge

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- For these use cases:

- Select item : throws a selections has already been made
- Insert coin : update current inserted value
- Execute transaction : Get selected item if money is enough
- Cancel transaction : return money and empty selected item

What will happen if some item has been selected?

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Challenge

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- For these use cases:

- Select item
- Insert coin
- Execute transaction
- Cancel transaction

What will happen if none item has been selected?

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Challenge

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- For these use cases:

- Select item : make a selection
- Insert coin
- Execute transaction
- Cancel transaction

What will happen if none item has been selected?

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Challenge

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- For these use cases:

- Select item : make a selection
- Insert coin : throws to ask user make a selection first
- Execute transaction
- Cancel transaction

What will happen if none item has been selected?

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Challenge

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- For these use cases:

- Select item : make a selection
- Insert coin : throws to ask user make a selection first
- Execute transaction : throws to ask user to make a selection first
- Cancel transaction

What will happen if none item has been selected?

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Challenge

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- For these use cases:

- Select item : make a selection
- Insert coin : throws to ask user make a selection first
- Execute transaction : throws to ask user to make a selection first
- Cancel transaction : maybe not doing anything or throw

What will happen if none item has been selected?

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Challenge

- Insert coin

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```
public void insertCoin(List<Coin> coins)
{
    if(selectedItem == null)
    {
        throw new Exception("You need to make a selection first");
    }
    else if(selectedItem != null)
    {
        currentCoins.add(coins);
    }
}
```

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Challenge

- 我们刚刚考虑了HAS_SELECTION 和 NO_SELECTION 的情况

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Challenge

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- 我们刚刚考虑了HAS_SELECTION 和 NO_SELECTION 的情况

- 那么对于：

- COINS_INSERTED
- VENDING

应该怎么办？

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Challenge

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```
public void insertCoin(List<Coin> coins)
{
    if(selectedItem == null)
    {
        throw new Exception("You need to make a selection first");
    }
    else if(selectedItem != null)
    {
        currentCoins.add(coins);
    }
    else if(VENDING)
    {
        throw new Exception("Be patient, item is coming out, dont need to pay once more");
    }
    ...
}
```

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Challenge

- State Design Pattern

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Challenge

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- State Design Pattern

States:

- HAS_SELECTION
- NO_SELECTION
- COINS_INSERTED
-VENDING

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Challenge

- State Design Pattern

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State related actions:

- select item
- insert coin
- execute transaction
- cancel transaction

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Classes

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VendingMachine
- List<Coin> coins - List<Item> items - Map<String, ItemInfo> itemIdentifiers - ItemInfo currentSelection - List<Coin> currentCoins - Map<ItemInfo, List<Item>> stock
+ float selectItem(String selection) + void insertCoins(List<Coin> coins) + Item executeTransaction() + List<Coin> cancelTranscation() + void refillItems(List<Item> items) - List<Coin> refund()

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Use cases
Select item
Insert coin
Execute transaction
Cancel transaction
Refill items

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Classes

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VendingMachine
- List<Coin> coins - List<Item> items - Map<String, ItemInfo> itemIdentifiers - ItemInfo currentSelection - List<Coin> currentCoins - Map<ItemInfo, List<Item>> stock
+ float selectItem(String selection) + void insertCoins(List<Coin> coins) + Item executeTransaction() + List<Coin> cancelTranscation() + void refillItems(List<Item> items) - List<Coin> refund()

<<interface>> State
+ float selectItem(String selection) + void insertCoins(List<Coin> coins) + Item executeTransaction() + List<Coin> cancelTranscation()

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Use cases
Select item
Insert coin
Execute transaction
Cancel transaction
Refill items

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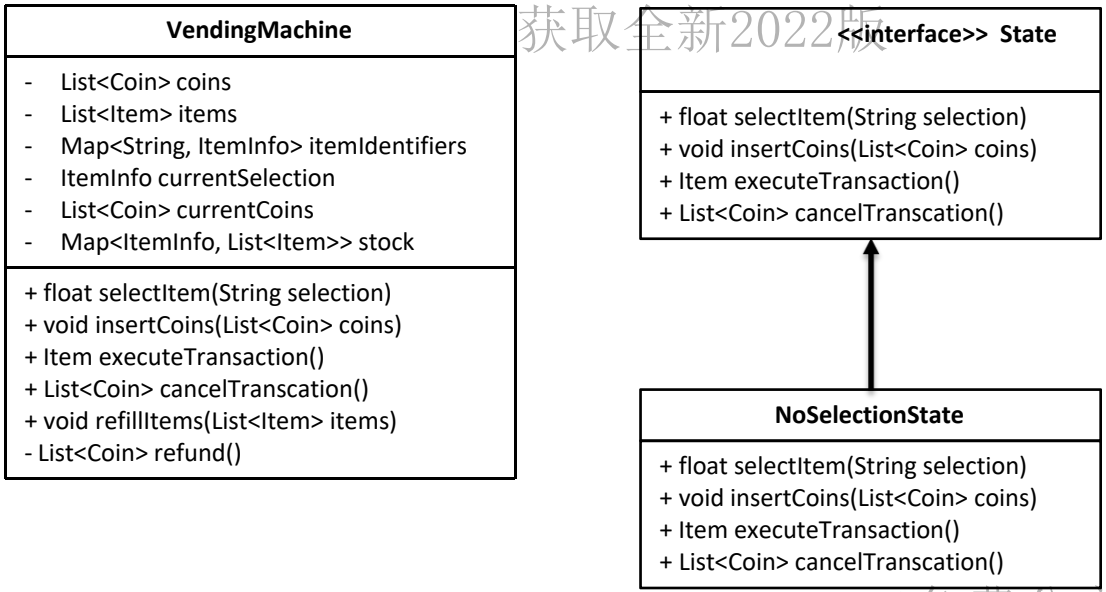

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Use cases
Select item
Insert coin
Execute transaction
Cancel transaction
Refill items

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Classes

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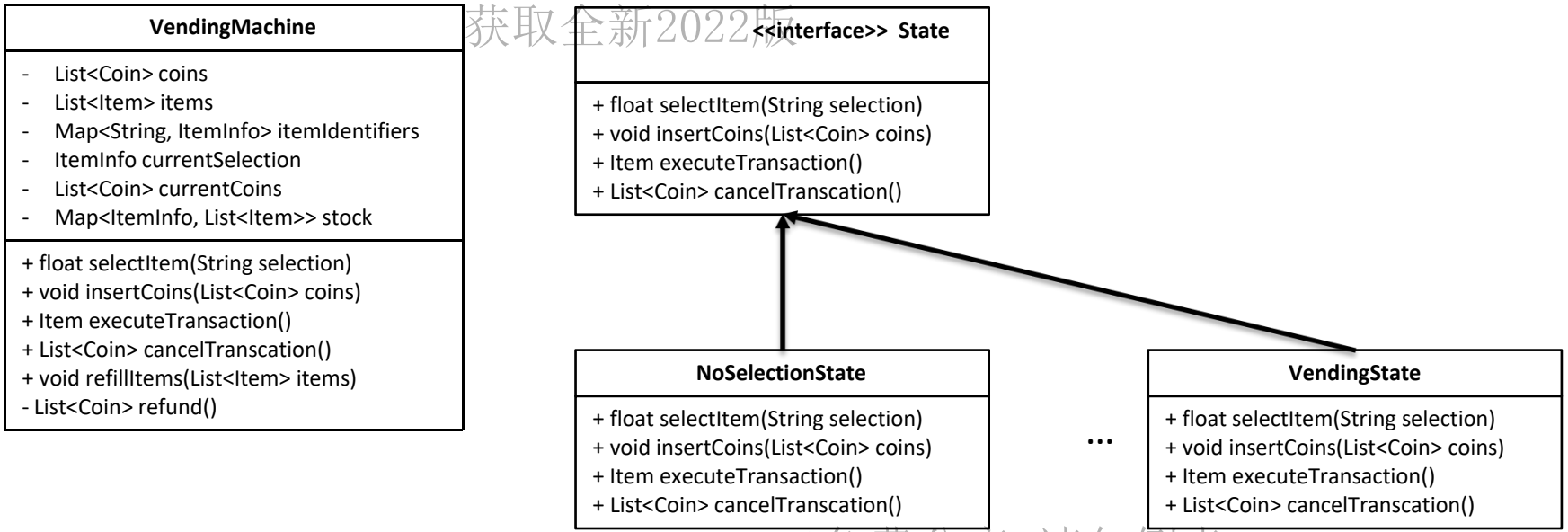

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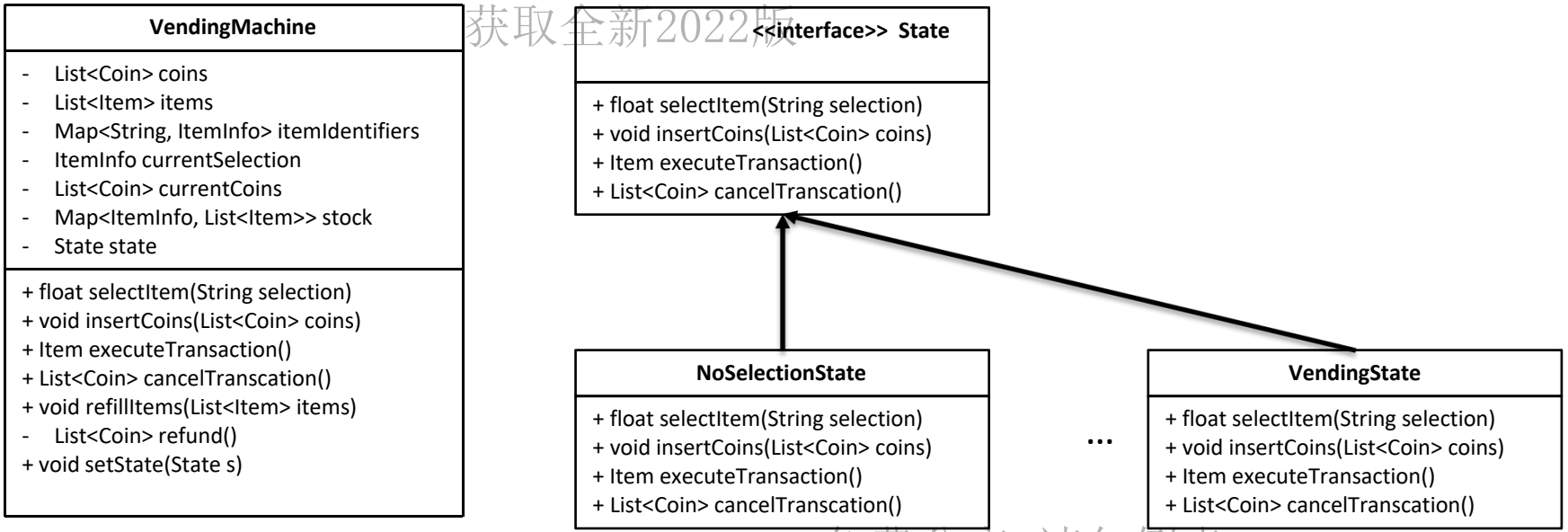

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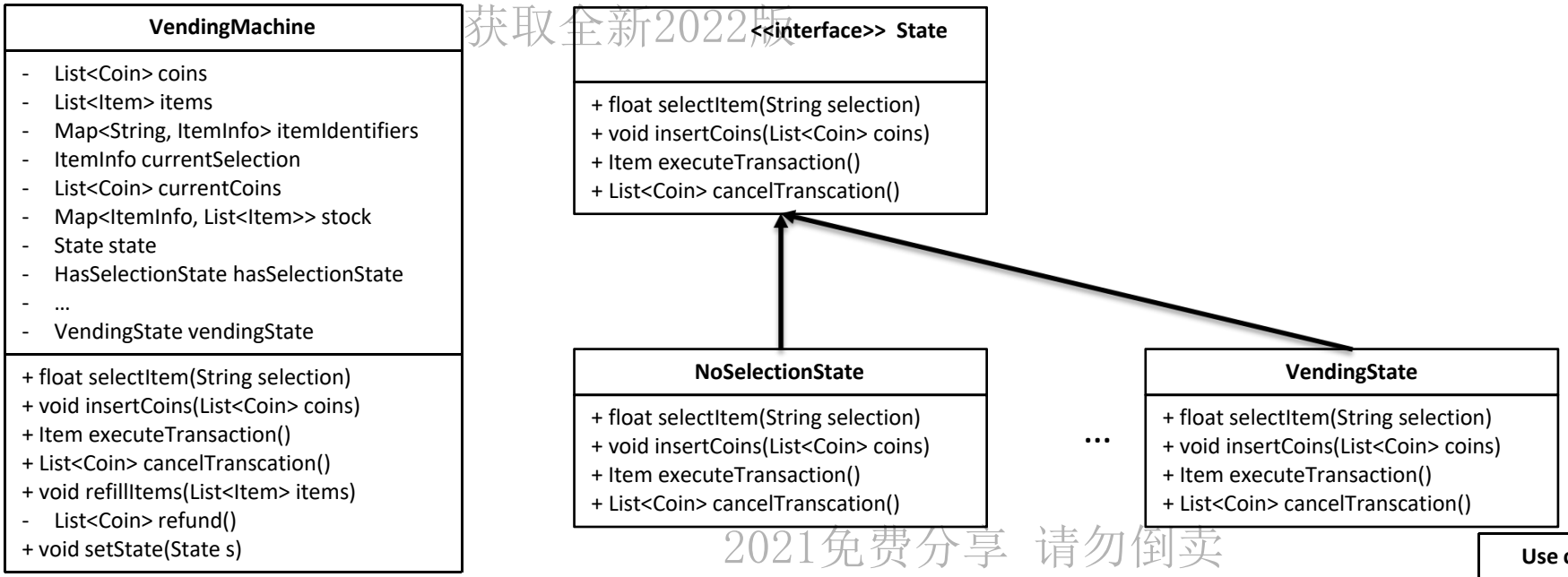

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Vending machine

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```
public interface State {
    public void selectItem(String selection);
    public void insertMoney(int value);
    public void executeTransaction();
    public int cancelTransaction();
}
```

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Vending machine

```java
public class VendingMachine {

    private AbstractState state;
    private NoSelectionState noSelectionState;
    private HasSelectionState hasSelectionState;
    private InsertedMoneyState insertedMoneyState;


    public VendingMachine()
    {

        noSelectionState = new NoSelectionState(this);
        hasSelectionState = new HasSelectionState(this);
        insertedMoneyState = new InsertedMoneyState(this);
        state = noSelectionState;

    }

    public void changeToNoSelectionState()
    {
        state = noSelectionState;
    }

    public void changeToHasSelectionState()
    {
        state = hasSelectionState;
    }

    public void changeToInsertedMoneyState()
    {
        state = insertedMoneyState;
    }

    public void selectItem(String selection)
    {
        state.selectItem(selection);
    }

    public void addMoney(int value)
    {
        state.insertMoney(value);
    }

    public void executeTransaction()
    {
        state.executeTransaction();
    }

    public int cancelTransaction()
    {
        return state.cancelTransaction();
    }
}
```

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```java
public class NoSelectionState implements AbstractState{

    VendingMachine vendingMachine;

    public NoSelectionState(VendingMachine vendingMachine) {
        this.vendingMachine = vendingMachine;
    }

    @Override
    public void selectItem(String selection) {
        // TODO Auto-generated method stub
        vendingMachine.setSelectedItem(selection);
        vendingMachine.changeToHasSelectionState();
    }

    @Override
    public void insertMoney(int value) {
        // TODO Auto-generated method stub
        System.out.println("Please make a selection first");
    }

    @Override
    public void executeTransaction() {
        // TODO Auto-generated method stub
        System.out.println("Please make a selection first");
    }

    @Override
    public int cancelTransaction() {
        // TODO Auto-generated method stub
        System.out.println("Please make a selection first");
        return 0;
    }

}
```

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Real life object

- 难度不大

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- 从Input / Output 考虑
- 继承关系
- 考虑Exception
- Design pattern if possible

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Coffee maker

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Clarify

- What

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关键字： Coffee maker

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Clarify

- What

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关键字： Coffee maker

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Clarify

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Clarify

- Input

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Clarify

- Output

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Clarify

- 对于本题

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Input: Coffee packs

Output: Expresso

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Clarify

- How

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Clarify

- How

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Clarify

- What are the functions that out coffee maker supports?

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Clarify

- 对于本题：

- Brew

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Core object

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CoffeeMaker

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Core object

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CoffeePack

CoffeeMaker

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Core object

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CoffeePack

CoffeeMaker

Expresso

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Use cases

- Coffee maker

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- Brew

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Classes

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CoffeeMaker

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Classes

- Use case: Brew

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Coffee machine expected to use a coffee pack to get expresso coffee

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Classes

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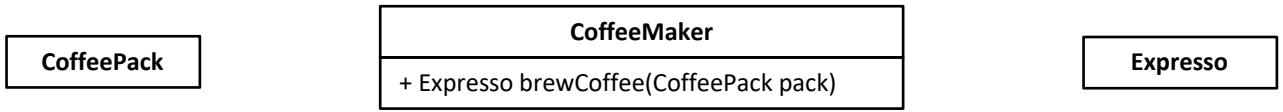

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Challenge

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如果需要能制作出多种咖啡(价格不同)，需要怎么做？

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Classes

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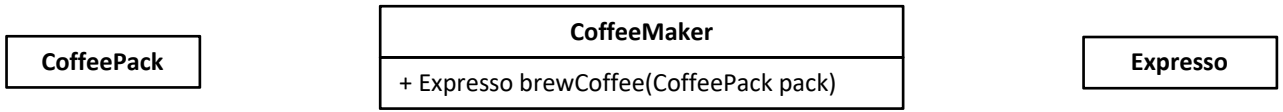

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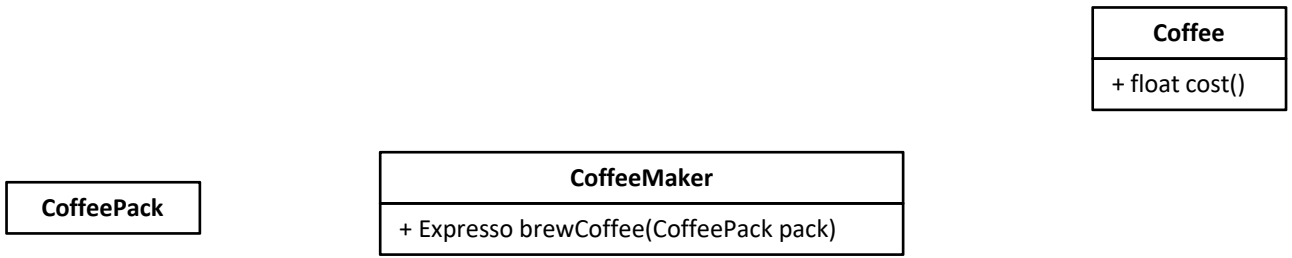

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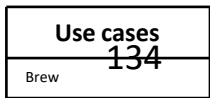

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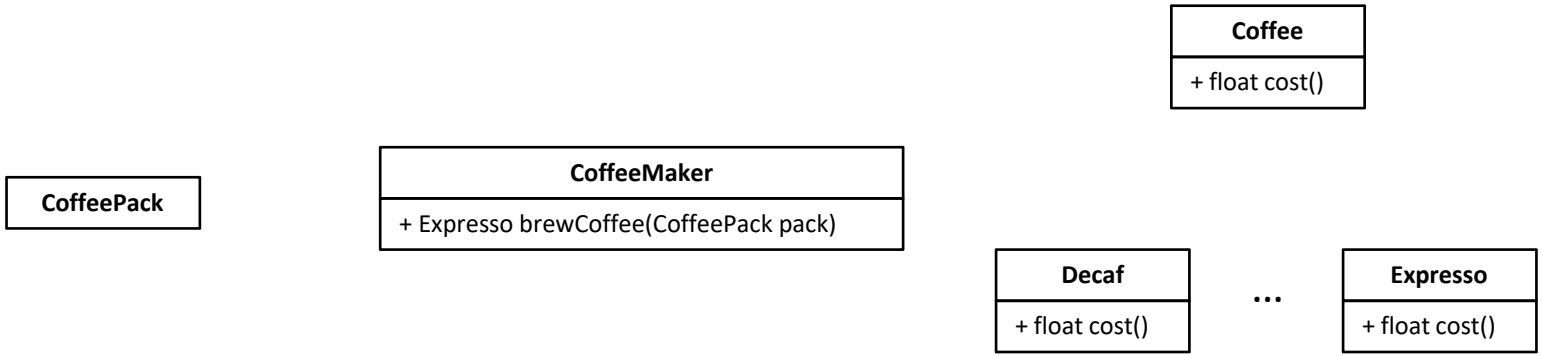

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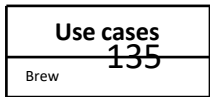

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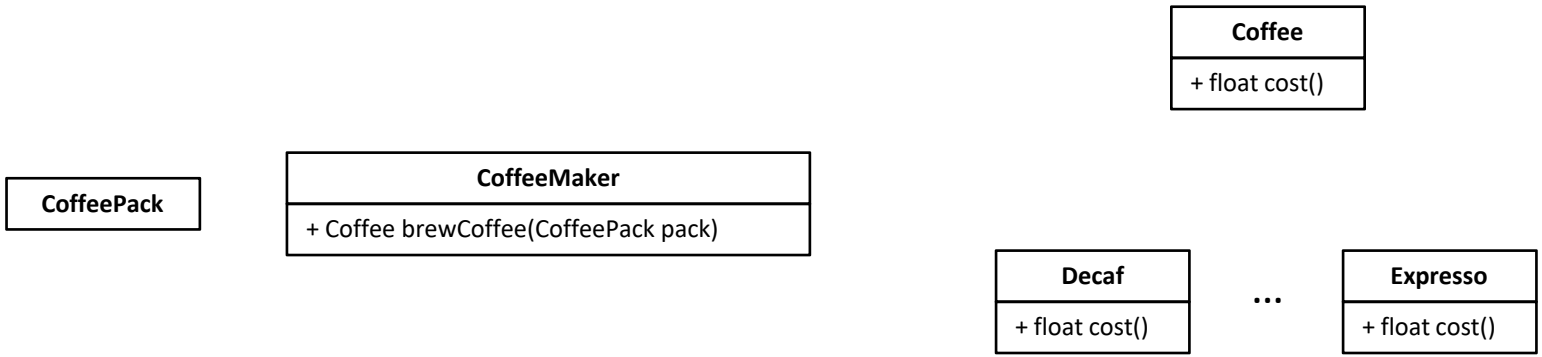

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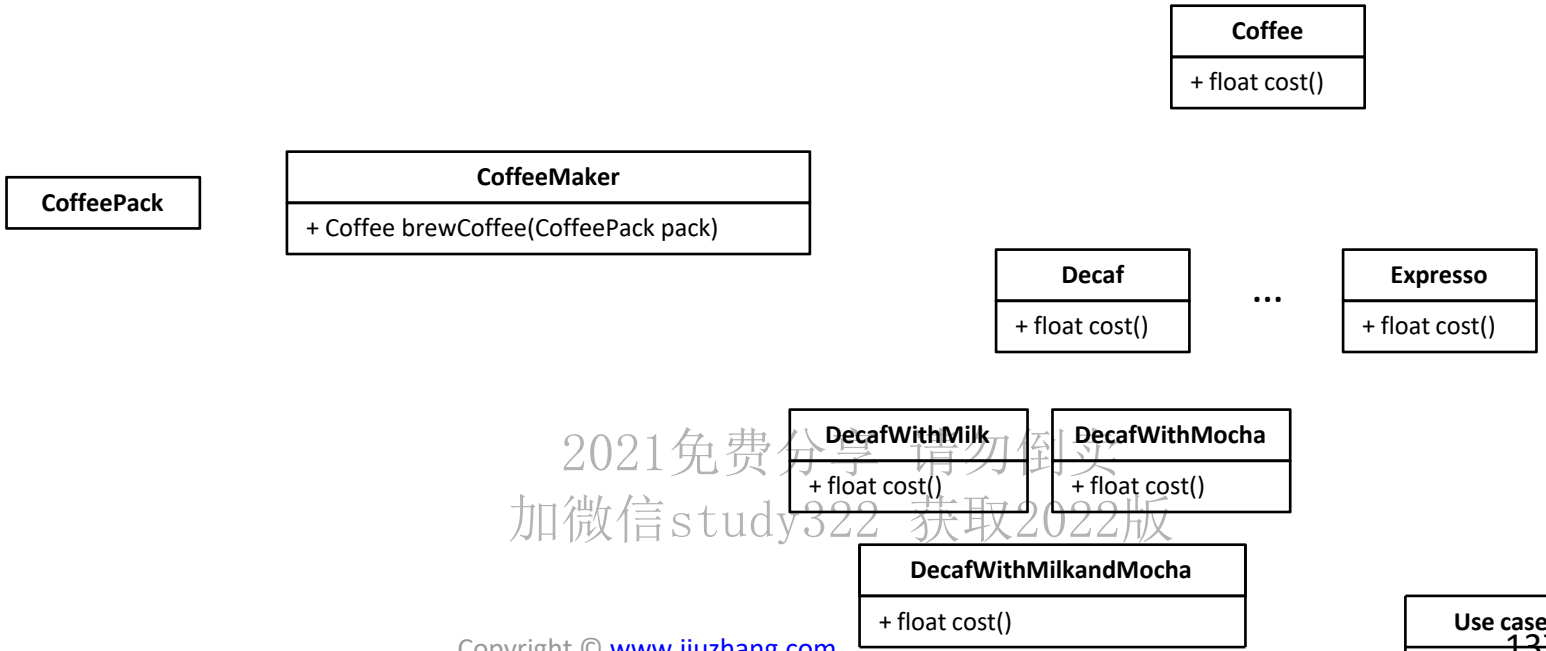

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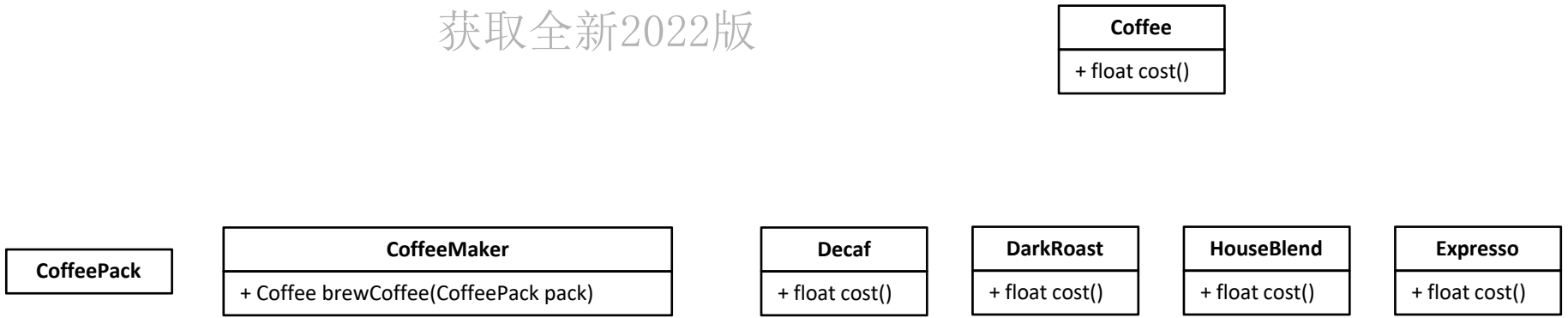

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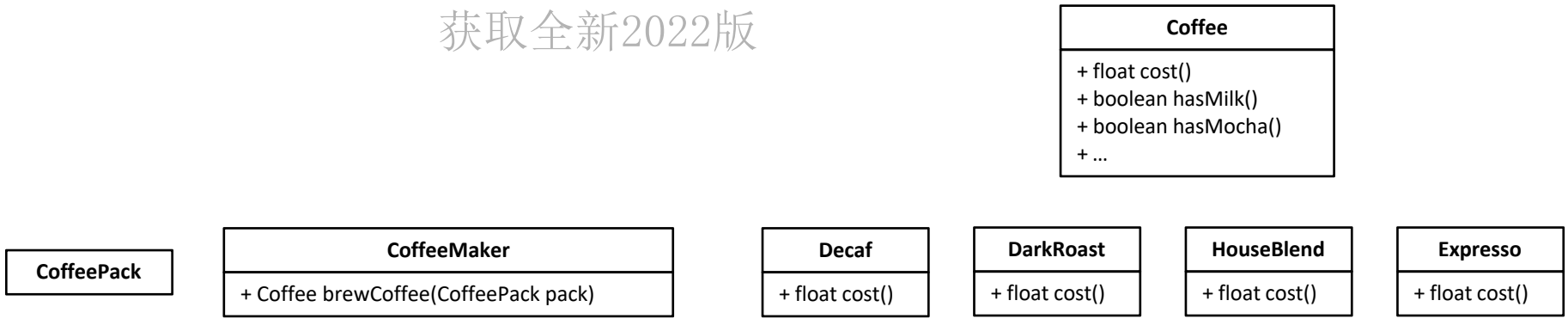

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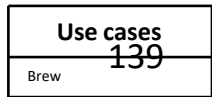

另一种继承

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```
public float cost()
{
    if(hasMilk())
    {
        cost += 0.5;
    }

    if(hasMocha())
    {
        cost += 0.5;
    }

    if(hasSoy())
    {
        cost += 0.5;
    }

    ...

    return cost;
}
```

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Decorator Design Pattern

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- Decorator pattern allows a user to add new functionality to an existing object without altering its structure. This type of design pattern comes under structural pattern as this pattern acts as a wrapper to existing class.

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Decorator

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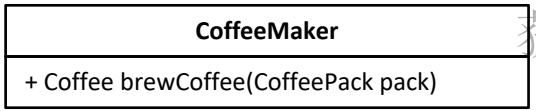

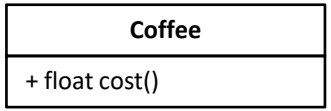

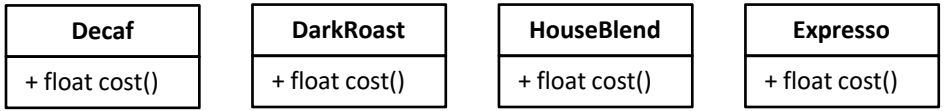

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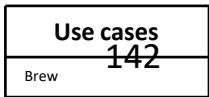

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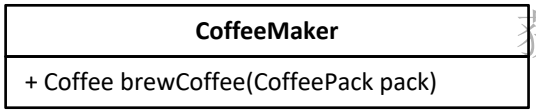

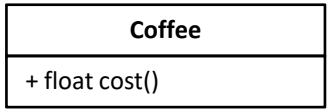

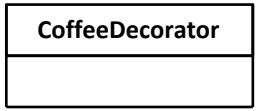

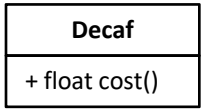

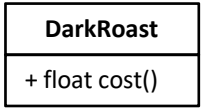

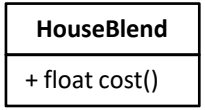

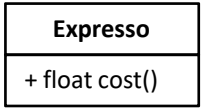

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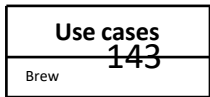

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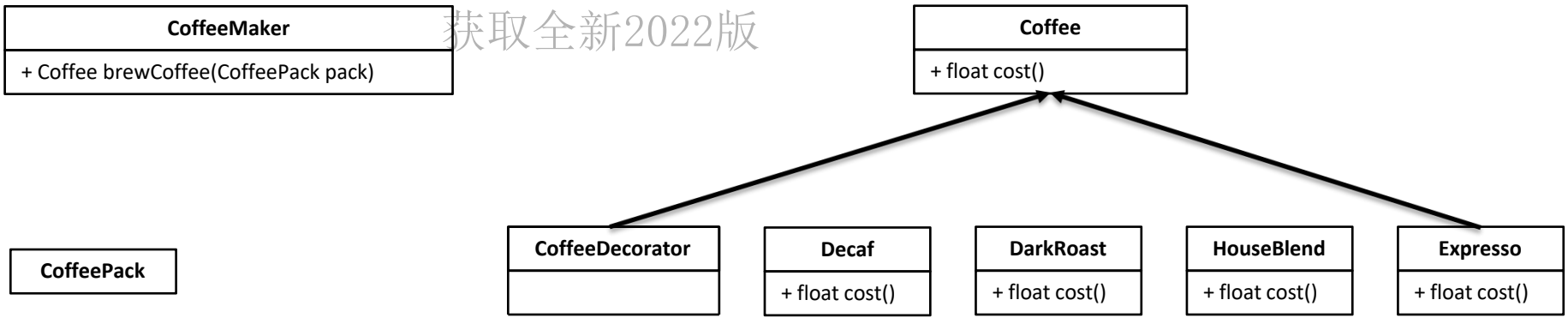

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Use cases
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Decorator

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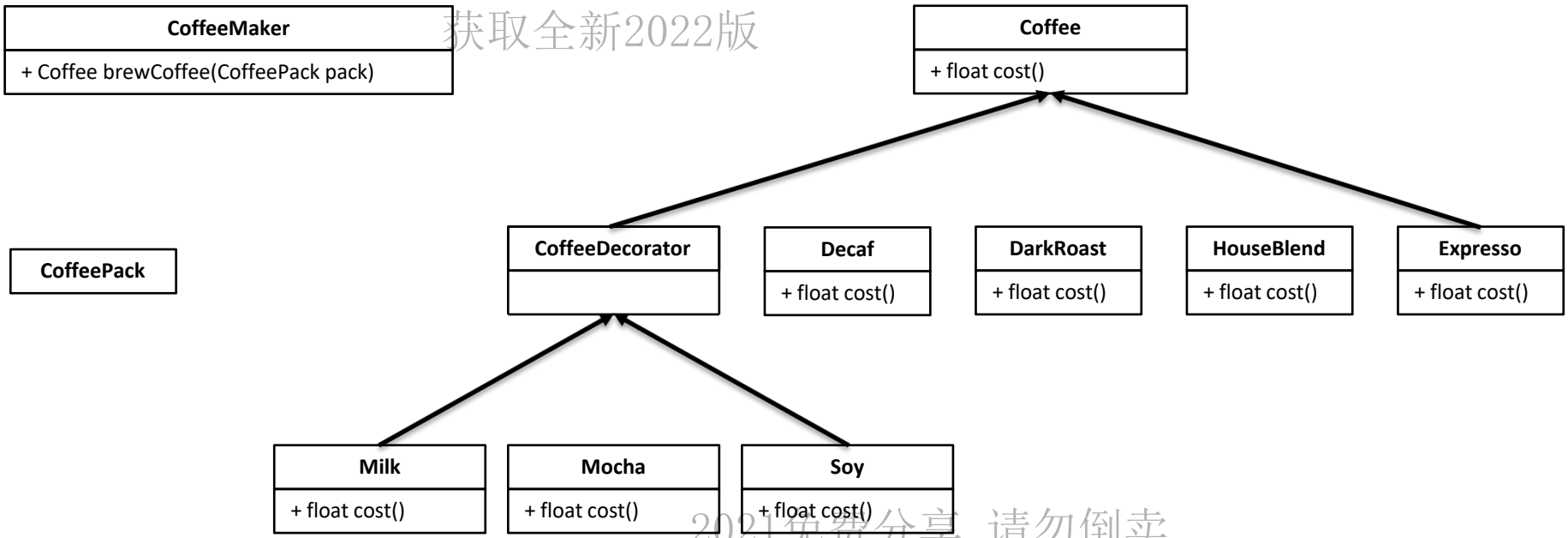

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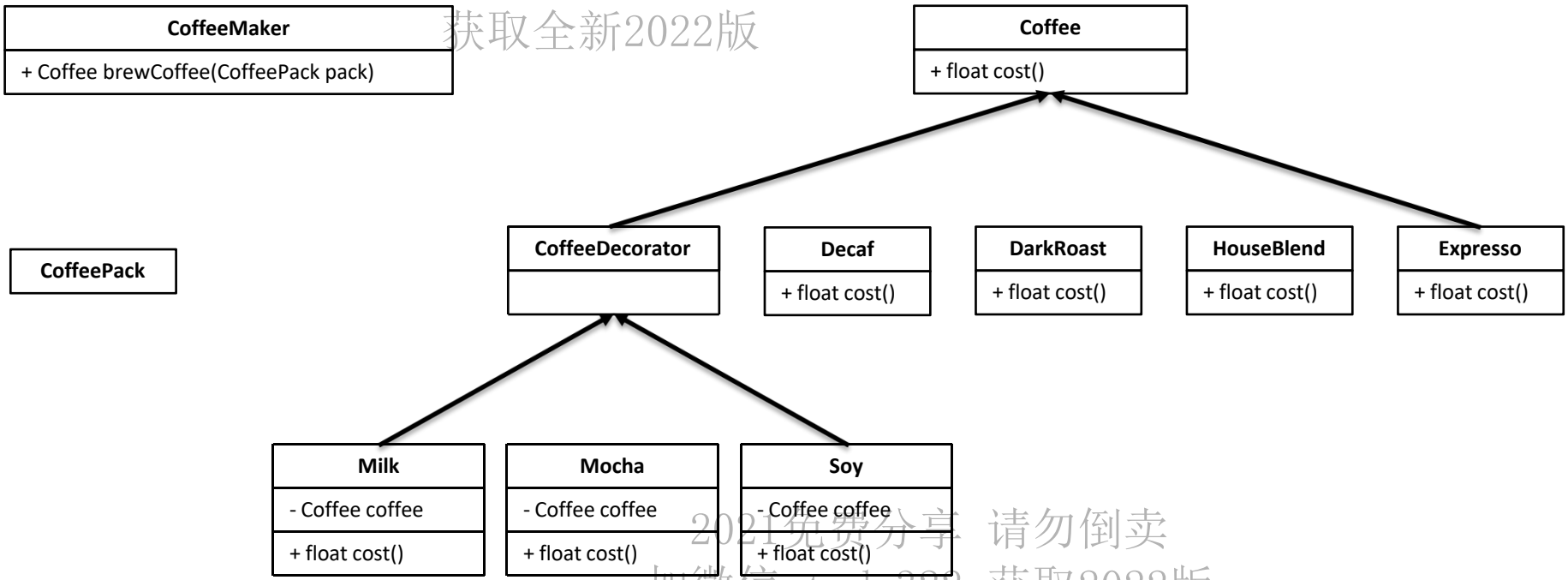

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Use cases
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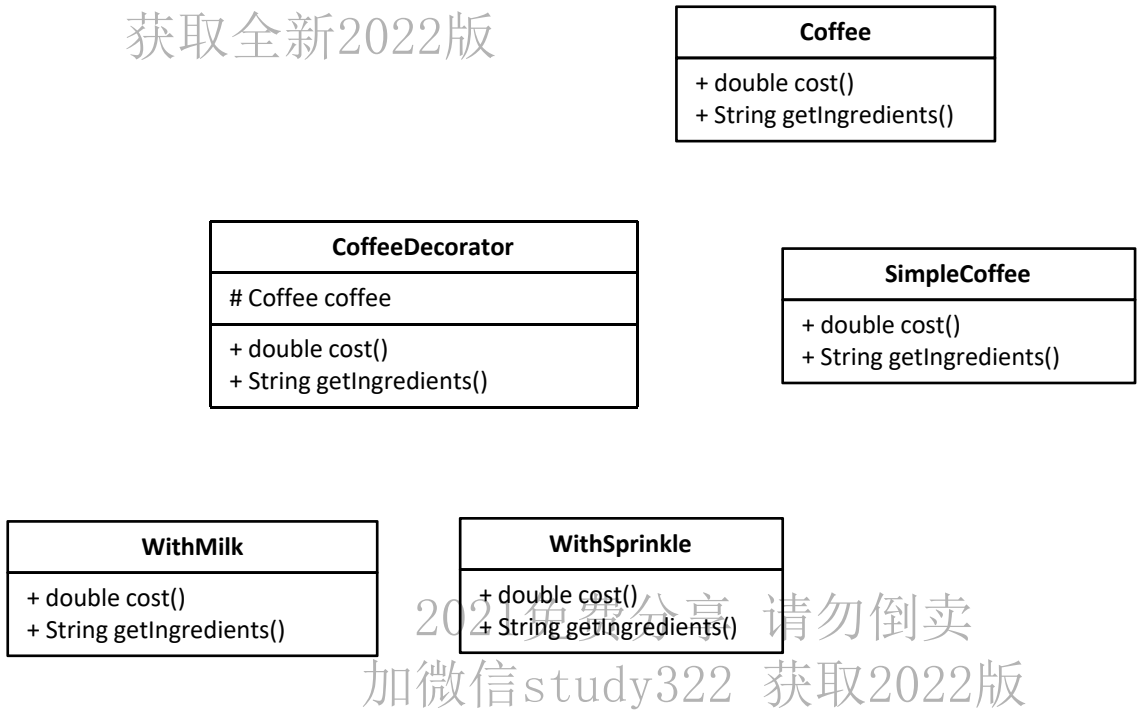

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Decorator

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```java
// The interface Coffee defines the functionality of Coffee implemented by decorator
public interface Coffee {
    public double getCost(); // Returns the cost of the coffee
    public String getIngredients(); // Returns the ingredients of the coffee
}

// Extension of a simple coffee without any extra ingredients
public class SimpleCoffee implements Coffee {
    @Override
    public double getCost() {
        return 1;
    }

    @Override
    public String getIngredients() {
        return "Coffee";
    }
}
```

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```
// Abstract decorator class - note that it implements Coffee interface
public abstract class CoffeeDecorator implements Coffee {
    protected final Coffee decoratedCoffee;

    public CoffeeDecorator(Coffee c) {
        this.decoratedCoffee = c;
    }

    public double getCost() { // Implementing methods of the interface
        return decoratedCoffee.getCost();
    }

    public String getIngredients() {
        return decoratedCoffee.getIngredients();
    }
}
```

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Decorator

```
// Decorator WithMilk mixes milk into coffee.
// Note it extends CoffeeDecorator.
class WithMilk extends CoffeeDecorator {
    public WithMilk(Coffee c) {
        super(c);
    }

    public double getCost() { // Overriding methods defined in the abstract superclass
        return super.getCost() + 0.5;
    }

    public String getIngredients() {
        return super.getIngredients() + ", Milk";
    }
}

// Decorator WithSprinkles mixes sprinkles onto coffee.
// Note it extends CoffeeDecorator.
class WithSprinkles extends CoffeeDecorator {
    public WithSprinkles(Coffee c) {
        super(c);
    }

    public double getCost() {
        return super.getCost() + 0.2;
    }

    public String getIngredients() {
        return super.getIngredients() + ", Sprinkles";
    }
}
```

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```
public class Main {
    public static void printInfo(Coffee c) {
        System.out.println("Cost: " + c.getCost() + "; Ingredients: " + c.getIngredients());
    }

    public static void main(String[] args) {
        Coffee c = new SimpleCoffee();
        printInfo(c);

        c = new WithMilk(c);
        printInfo(c);

        c = new WithSprinkles(c);
        printInfo(c);
    }
}
```

The output of this program is given below:

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```
Cost: 1.0; Ingredients: Coffee
Cost: 1.5; Ingredients: Coffee, Milk
Cost: 1.7; Ingredients: Coffee, Milk, Sprinkles
```

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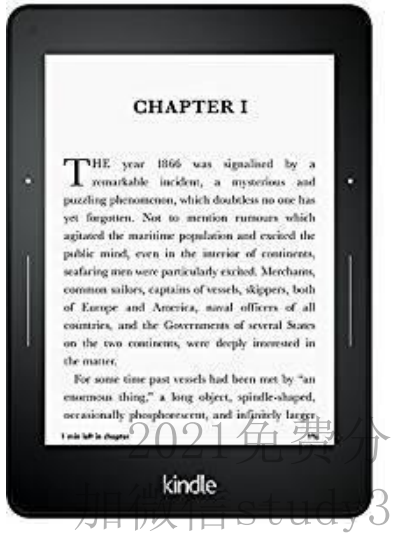

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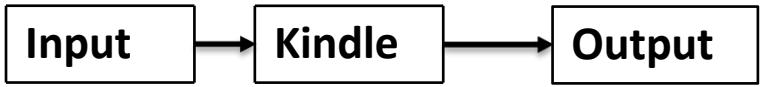

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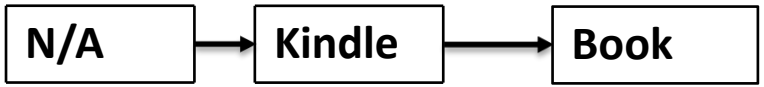

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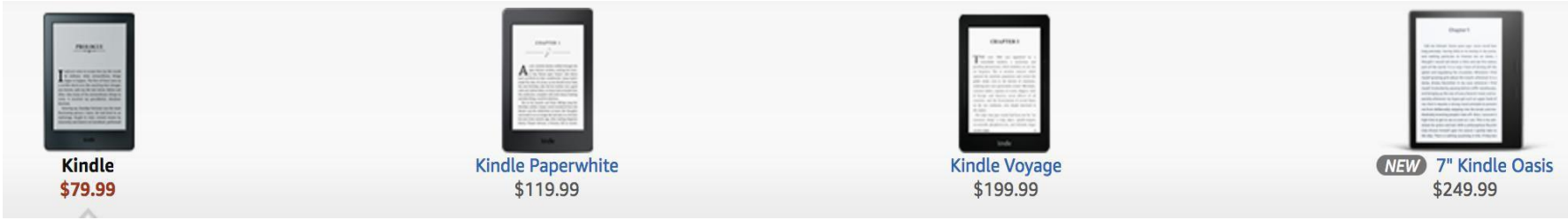

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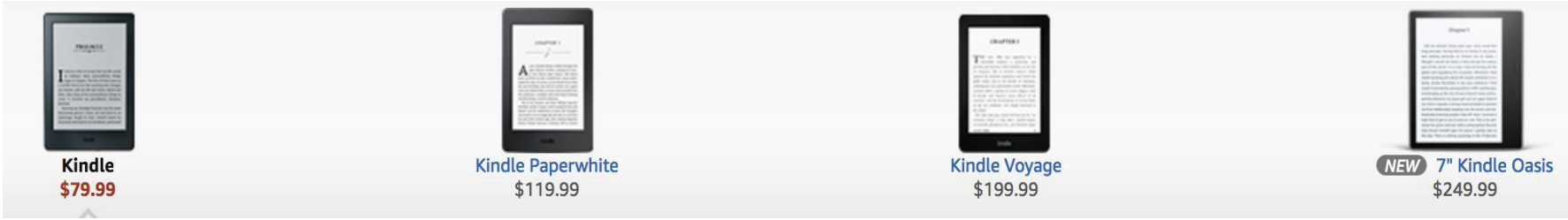

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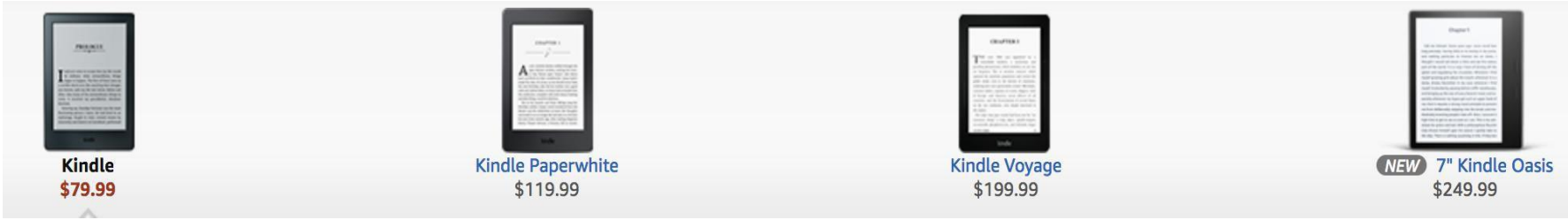

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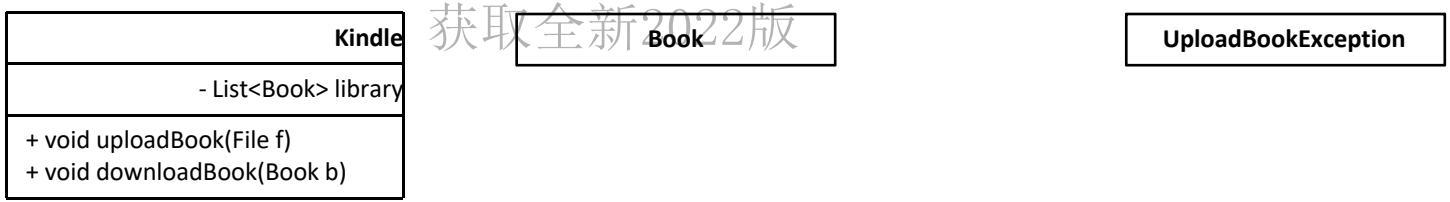

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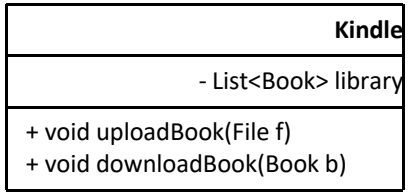

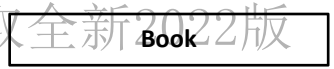

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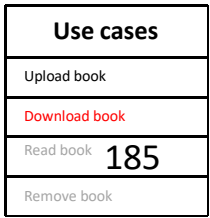

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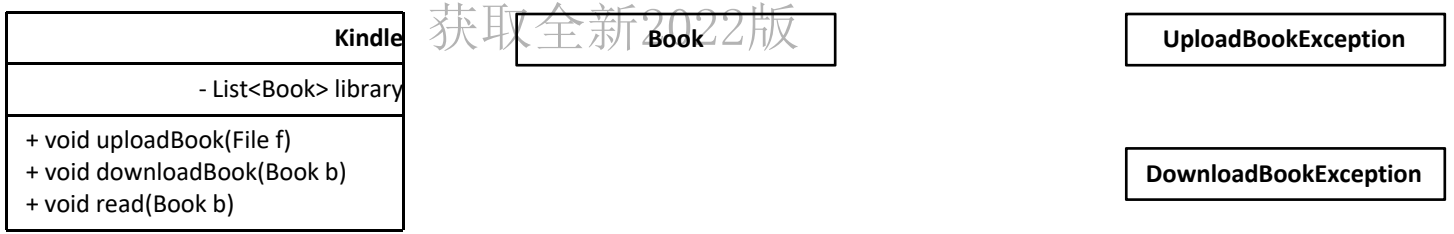

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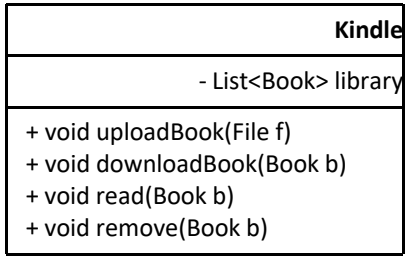

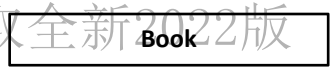

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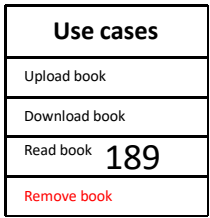

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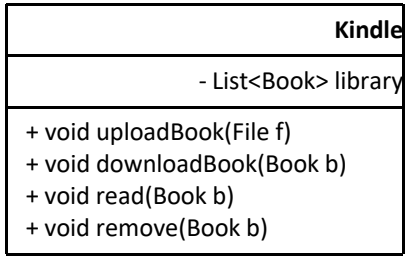

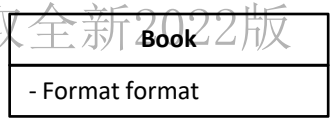

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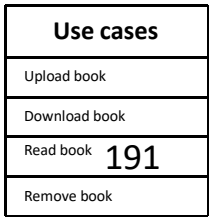

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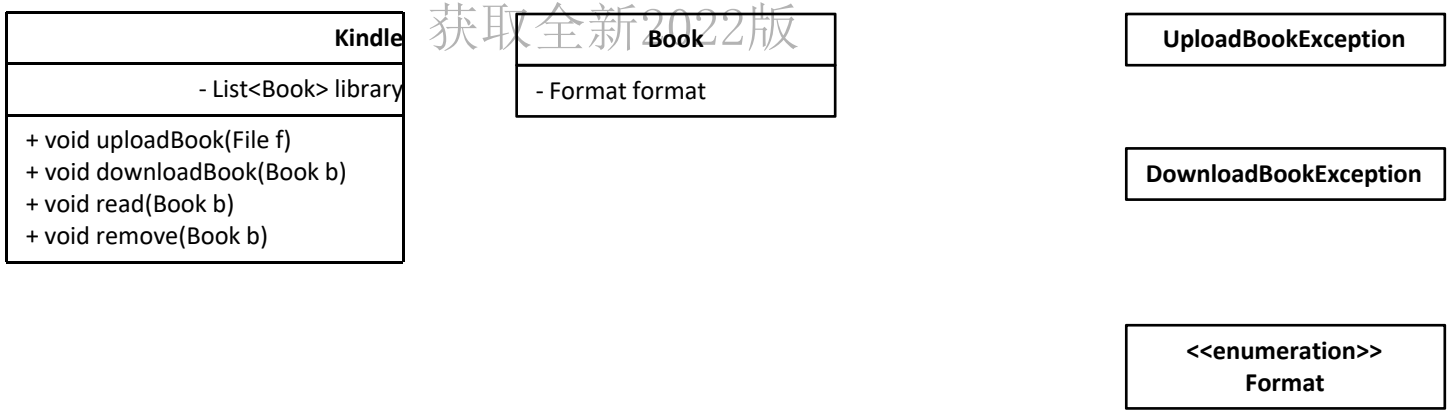

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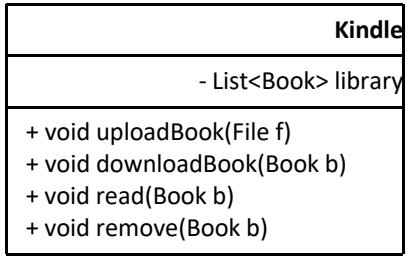

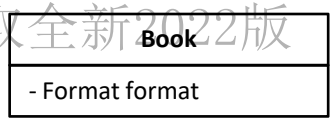

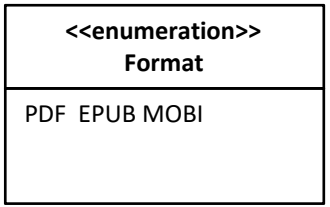

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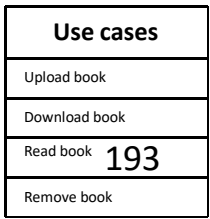

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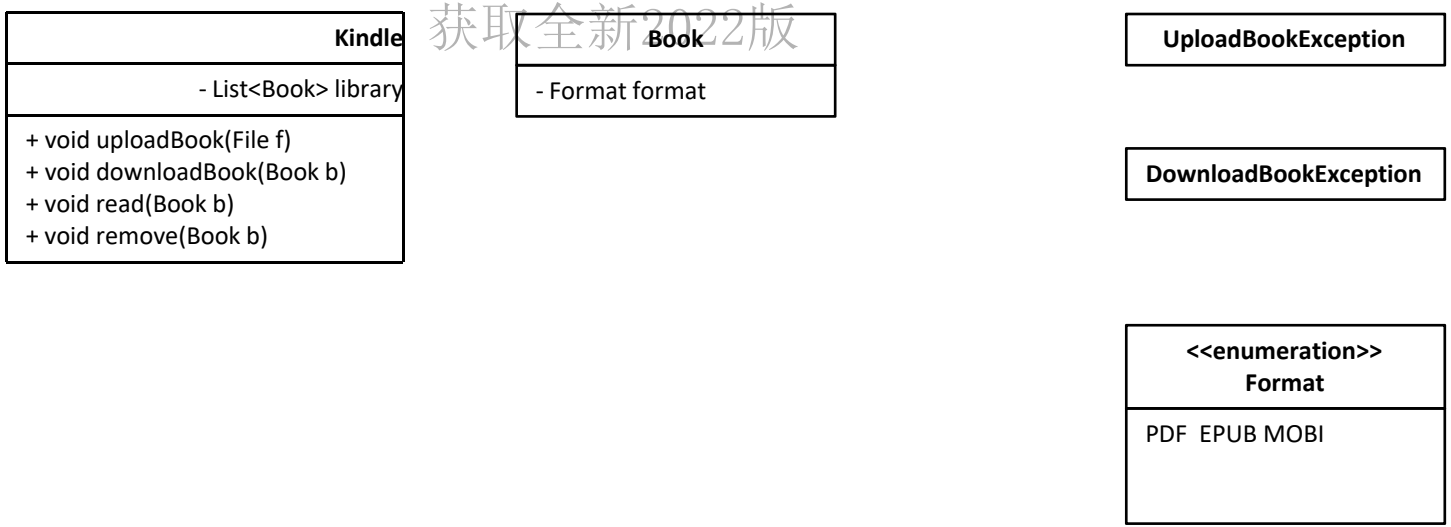

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Challenge

- How would read book work?

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```
public void read(Book book)
{
    if(book.getFormat == Format.PDF)
    {
        PDFReader reader = new PDFReader(book);
        reader.display();
    }
    else if(book.getFormat == Format.MOBI)
    {
        MOBIReader reader = new MOBIReader(book);
        reader.display();
    }
    else if(book.getFormat == Format.EPUB)
    {
        EPUBReader reader = new EPUBReader(book);
        reader.display();
    }
}
```

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Challenge

- Solution: Factory design pattern

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Factory design pattern

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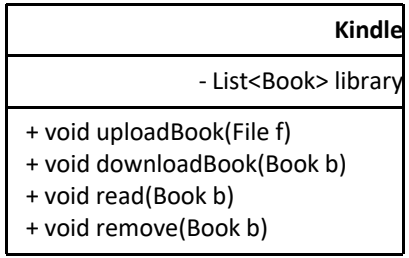

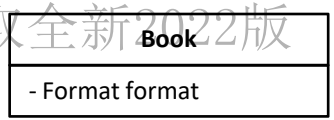

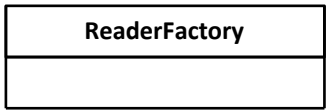

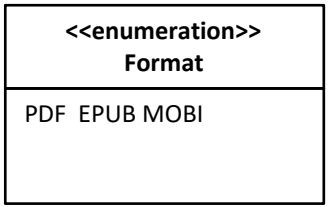

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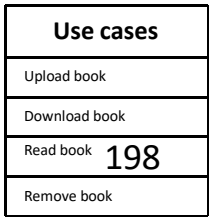

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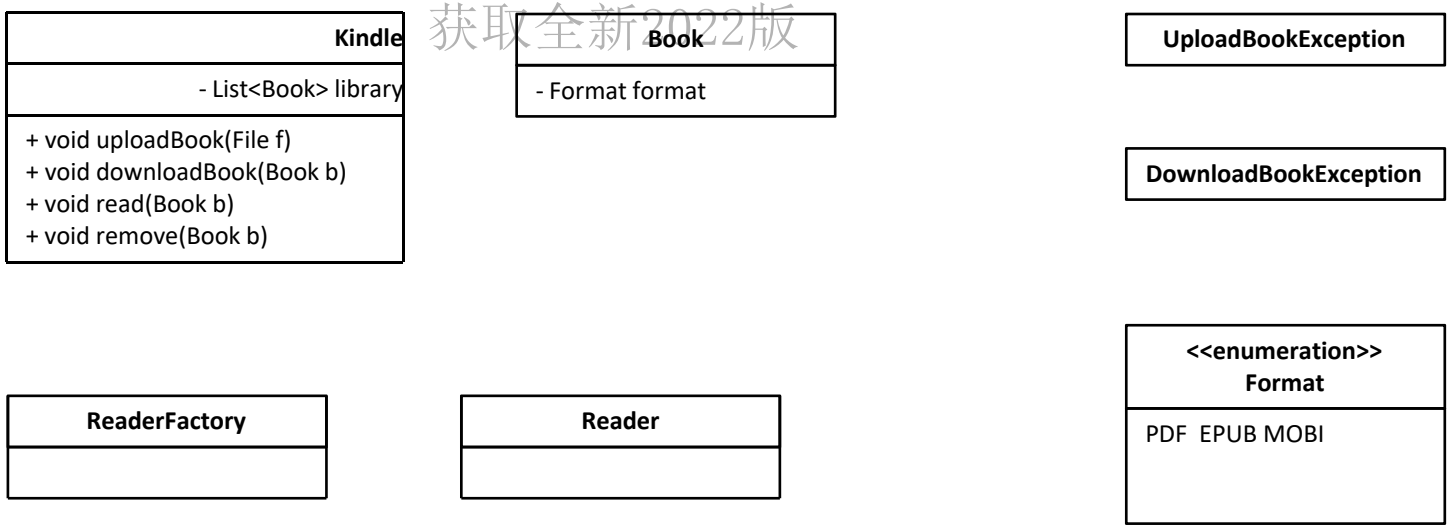

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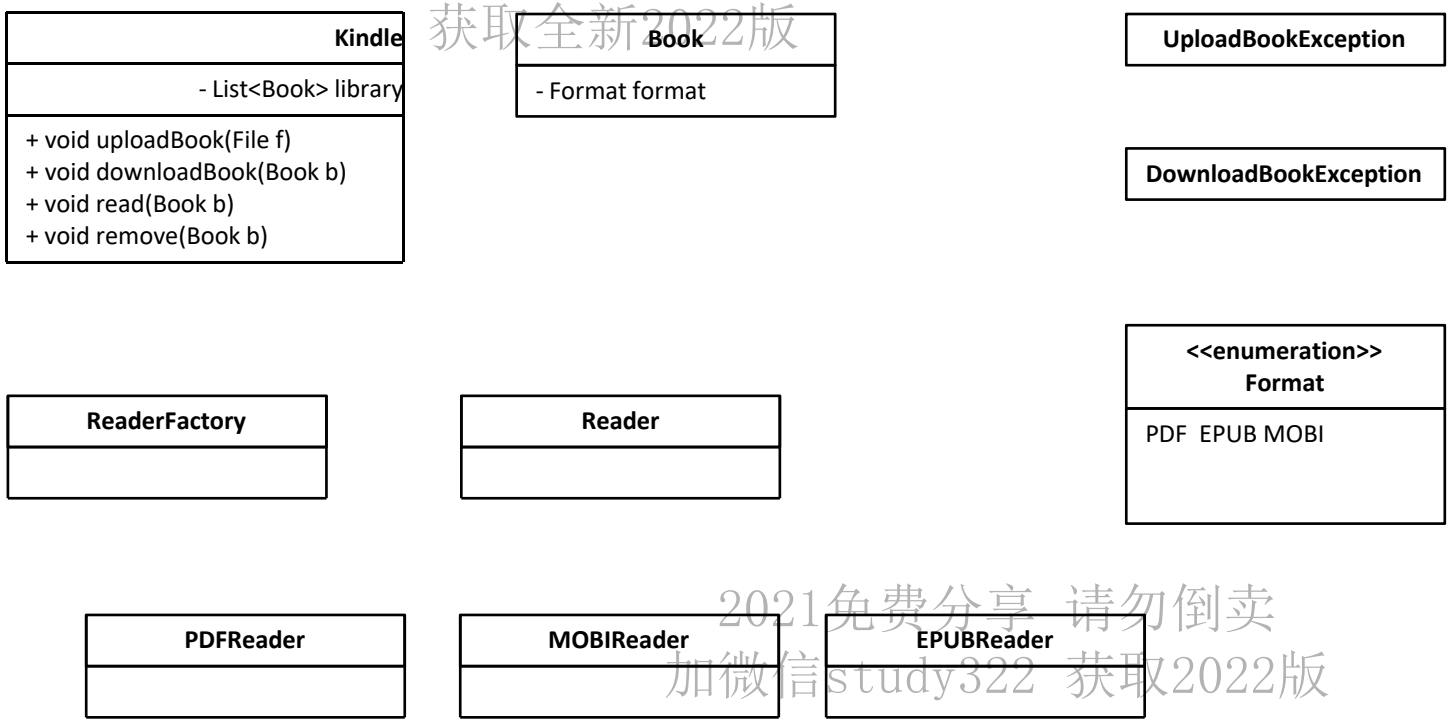

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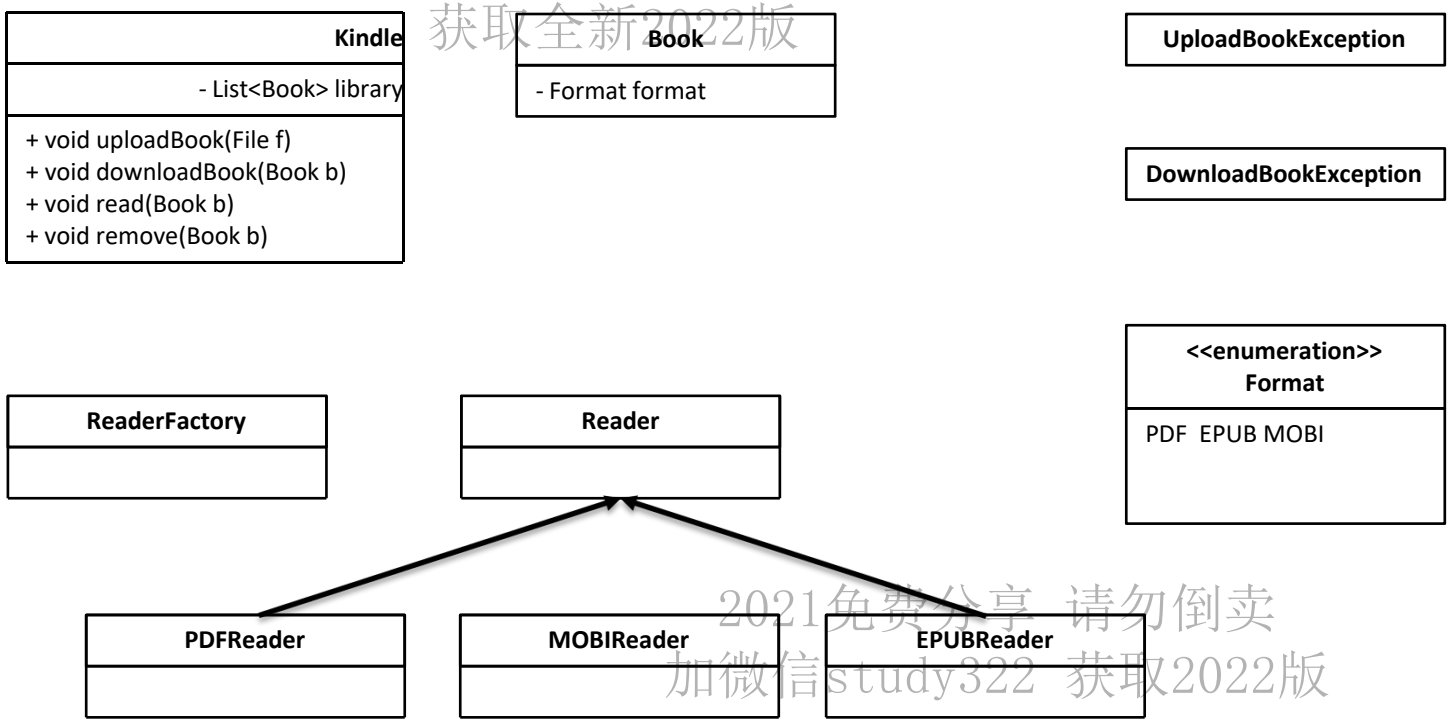

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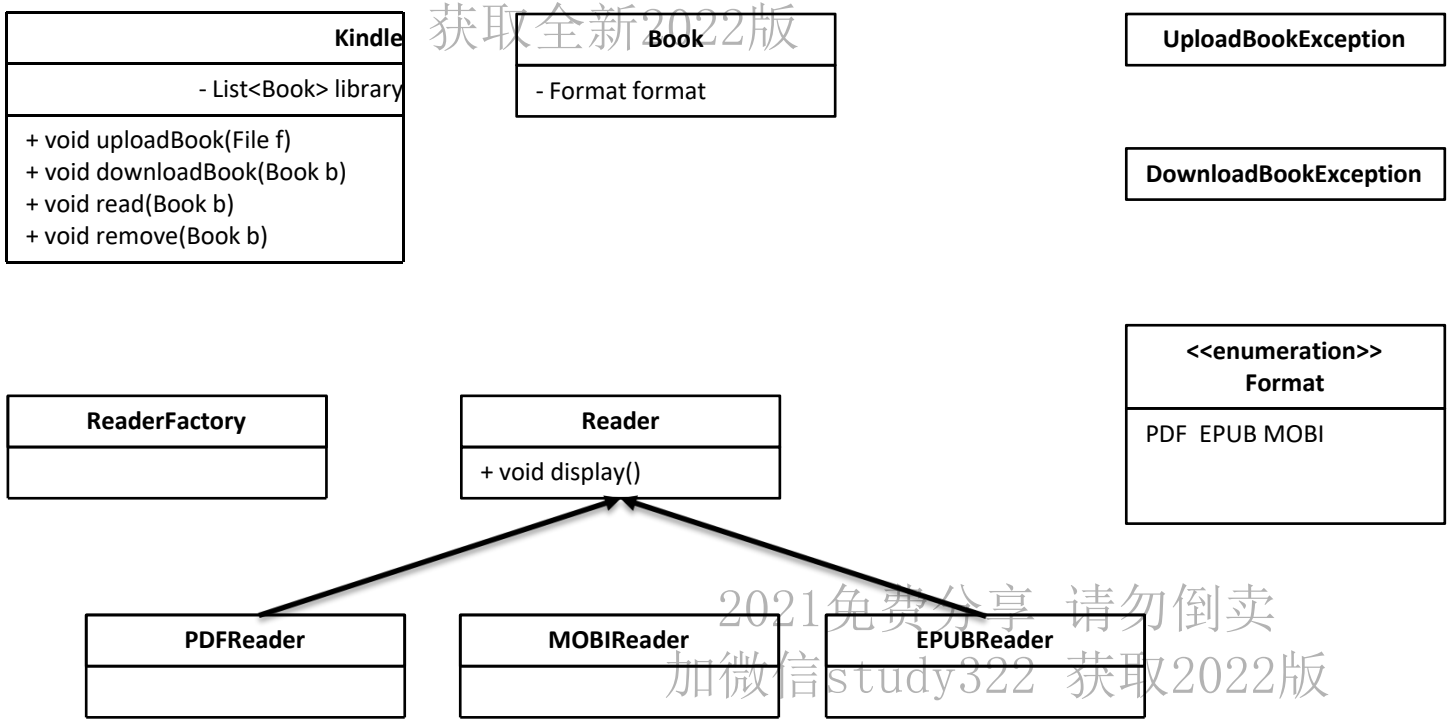

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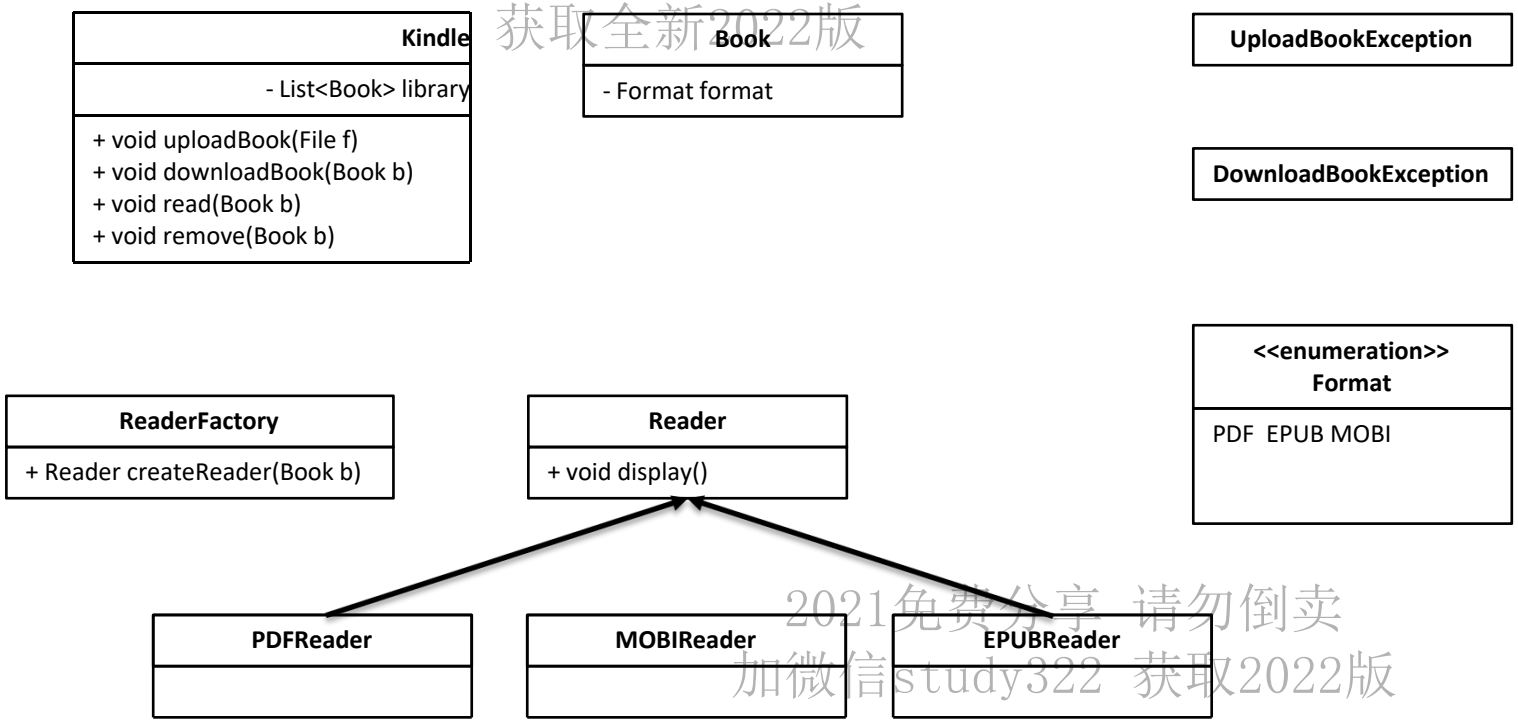

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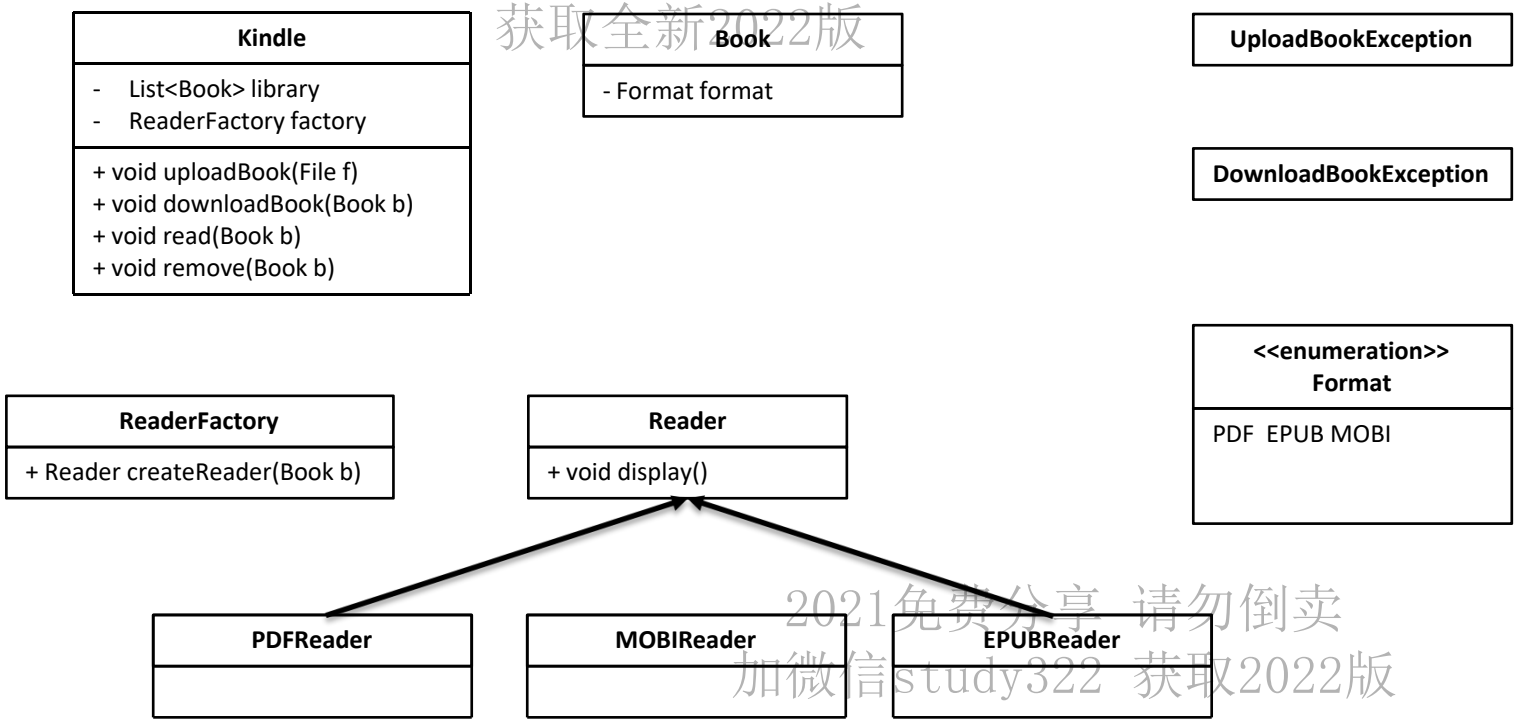

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Simple factory

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```
public Reader createReader(Book book)
{
    if(book.getFormat == Format.PDF)
    {
        return new PDFReader(book);
    }
    else if(book.getFormat == Format.MOBI)
    {
        return new MOBIReader(book);
    }
    else if(book.getFormat == Format.EPUB)
    {
        return new EPUBReader(book);
    }
    retrun null;
}
```

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```
Reader reader = factory.createReader(book);
reader.display();
```

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Factory design pattern

- Factory method
- Abstract factory

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Factory method

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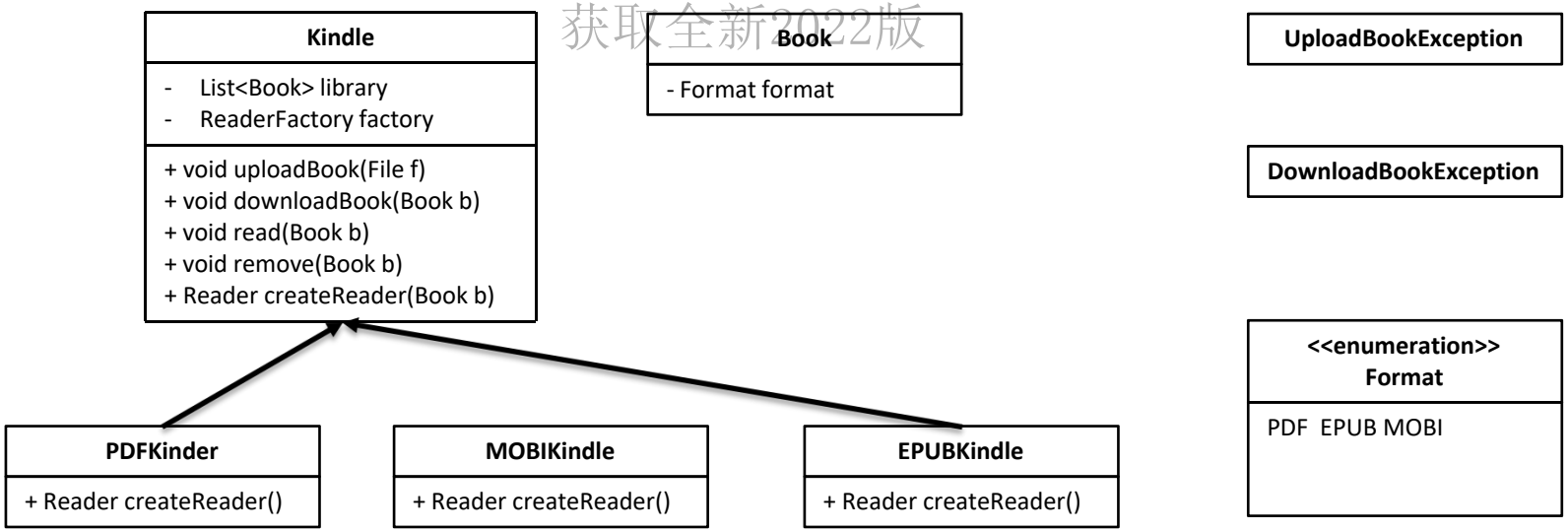

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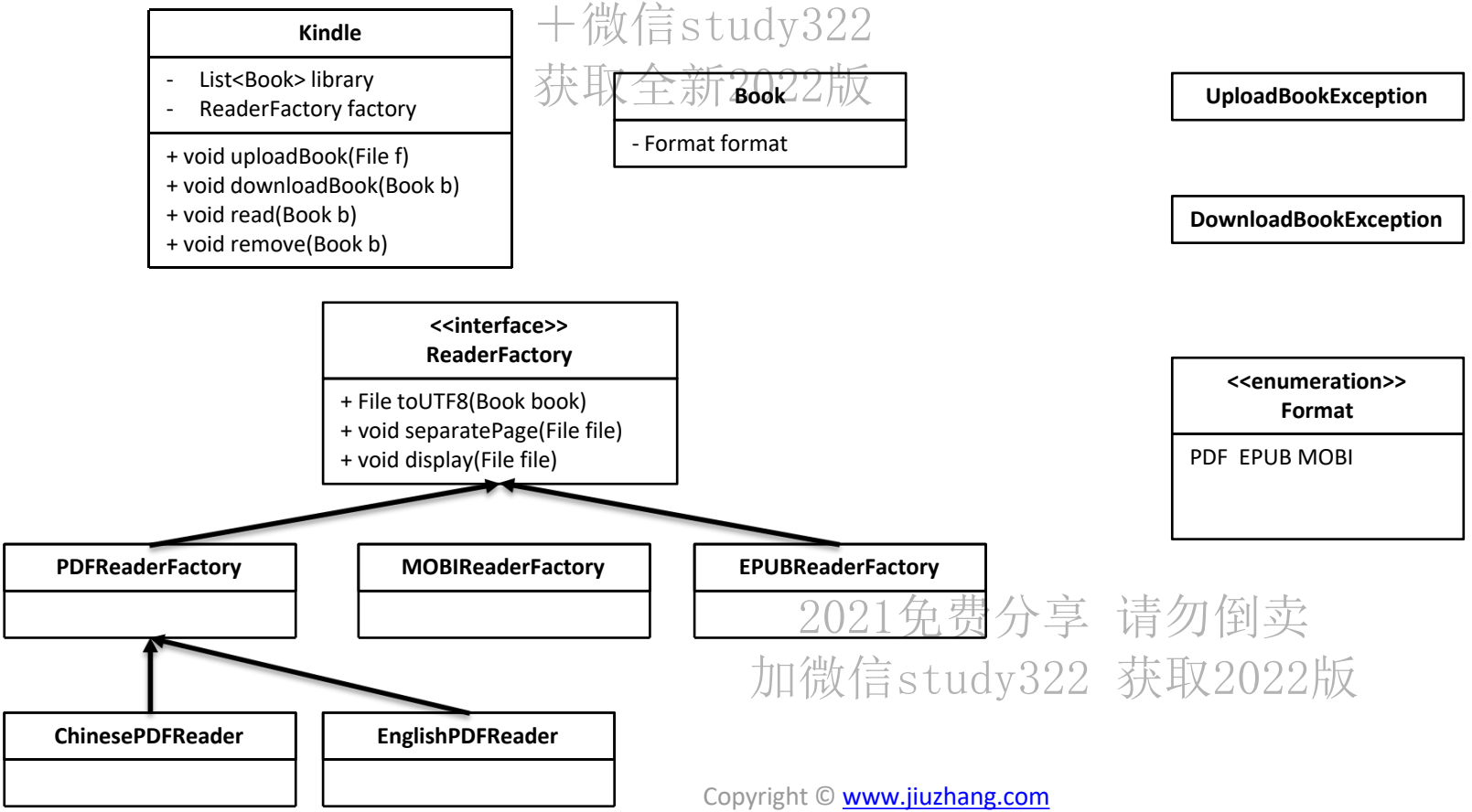
Abstract factory



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Strategy v.s. Factory

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Strategy v.s. Factory

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42

Strategy is about behavior. Factory is about creation/instatation.

Suppose you have an algorithm, to calculate a discount percentage. You can have 2 implementations of that algorithm; one for regular customers, and one for extra-ordinary good customers.

You can use a strategy DP for this implementation: you create an interface, and 2 classes that implement that interface. In one class, you implement the regular discount-calculation algorithm, in the other class you implement the 'good customers' algorithm.

Then, you can use a factory pattern to instantiate the class that you want. The factory method thus instantiates either the regular customer-discount algorithm, or the other implementation.

In short: the factory method instantiates the correct class; the strategy implementation contains the algorithm that must be executed.

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answered Mar 21 '11 at 8:16

Frederik Gheysels
45.8k ● 8 ● 78 ● 136

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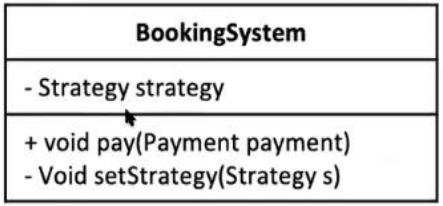

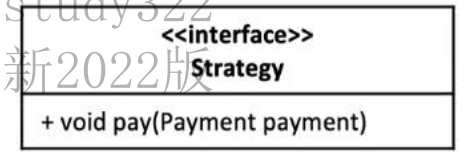

```
String account = payment.getAccount();
String password = payment.getPassword();
```

```
String cardId = payment.getCardId();
String name = payment.getName();
String cvv = payment.getCvv();
```

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Strategy v.s. Factory

```
public class StrategyFactory
{
    public Strategy createStrategy(Payment payment)
    {
        if(payment.getMethod().equals("paypal"))
        {
            strategy = new PaypalStrategy();
        }
        else if(payment.getMethod().equals("credit card"))
        {
            strategy = new CreditCardStrategy();
        }
    }
}

public void pay(Payment payment)
{
    strategy = createStrategy(payment);
    strategy.processPayment(payment);
}
```

```
public interface Strategy
{
    public void processPayment(Payment payment);
}

public class PaypalStrategy implements Strategy
{
    public void processPayment(Payment payment)
    {
        // get paypal account
        // get paypal password
        // ...
    }
}
```

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OOD 面向对象设计

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```
1 // Use cases:
2 // - Upload Ebook
3 // - Read Ebook
4 // - Download Ebook
5 // - Delete Ebook
```

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OOD 面向对象设计


```
// Upload Ebook
// Steps:
//  - Check if book is valid, and kindle has storage for it
//  - Add book to libaray
void uploadEbook(Book book) throws UploadFailureException
{

}
```

```
// Download Ebook
// Steps:
//  - Check if book is valid, and kindle has storage for it
//  - Add book to libaray
void downloadEbook(Book book) throws DownloadFailureException
{

}
```

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OOD 面向对象设计

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```
25 // Delete Ebook
26 // Steps:
27 //  - remove from library
28 void deleteEbook(Book book) throws DeleteFailureException
29 {
30
31 }
```

```
33 // Read Ebook
34 // Steps:
35 //  - Check if book format can be supported
36 //  - Finder approperite reader for Ebook
37 void read(Book book) throws ReadFailureException
38 {
39
40 }
```

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OOD 面向对象设计

```
7  class Book
8  {
9      // getters
10     ...
11
12     // setters
13     ...
14
15     private int size;
16     private Format format;
17 }
```

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OOD 面向对象设计

九章算法

```java
class kindle
{
  private int availableStorage;
  private Set<Format> supportedFormats;
  private List<Book> library;

  // Upload Ebook
  // Steps:
  //  - Check if book is valid, and kindle has storage for it
  //  - Add book to libaray
  void uploadEbook(Book book) throws UploadFailureException
  {
    if (availableStorage <= book.getSize())
    {
      throw new UploadFailureException("storage full");
    }
    if (!supportedFormats.contains(book.getFormat()))
    {
      throw new UploadFailureException("Unsupported format");
    }
    library.add(book);
  }

```

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OOD 面向对象设计

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```
42  // Download Ebook
43  // Steps:
44  //  - Check if book is valid, and kindle has storage for it
45  //  - Add book to libaray
46  void downloadEbook(Book book) throws DownloadFailureException
47  {
48      // same as upload
49  }
```

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九章算法

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```
51  // Delete Ebook
52  // Steps:
53  //   - remove from library
54  void deleteEbook(Book book) throws DeleteFailureException
55  {
56      // remove from library
57  }
```

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```
61  // Read Ebook
62  // Steps:
63  //   - Check if book format can be supported
64  //   - Finder approperite reader for Ebook
65  void read(Book book) throws ReadFailureException
66  {
67    if (!supportedFormats.contains(book.getFormat()))
68    {
69      throw new ReadFailureException("Unsupported format");
70    }
71    Reader reader = readerFactory.create(book);
72    reader.read(book);
73  }
74 }
```

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OOD 面向对象设计

九章算法

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```
19 class kindle
20 {
21   private int availableStorage;
22   private Set<Format> supportedFormats;
23   private List<Book> library;
24   private ReaderFactory readerFactory;
25
```

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OOD 面向对象设计


```
enum Format
{
  PDF,
  EPUB
}

abstract Class Reader
{
  private Format format;
  public abstract void read(Book book)
  {
  }
}

class PDFReader extends Reader
{
  public void read(Book book)
  {
    // read PDF
  }
}

Class ReaderFactory
{
  public Reader create(Book book) throws UnknownFormatException
  {
    switch(book.getFormat())
    {
      case PDF:
        return new PDFReader();
      ...
      default:
        throw new UnknownFormatException("Unkown format");
    }
  }
}
```

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Recap

- 常见的实物类面向对象设计

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Recap

- 常见的实物类面向对象设计
- Input -> 题目主体 -> Output
- State design pattern
- Decorate design pattern
- Factory design pattern

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