Deriving Abstract Factory

Loosening the coupling when creating objects...

Prelude

The Receipt class revisited

- Add responsibility to print itself

Receipt
• know its value in minutes parking time • print itself

- Provided by method

```
public void print(PrintStream stream);
```

- Result:

```
-----------------------------------------
-------  P A R K I N G   R E C E I P T  -------
              Value 049 minutes.
            Car parked at 08:06
-----------------------------------------
```

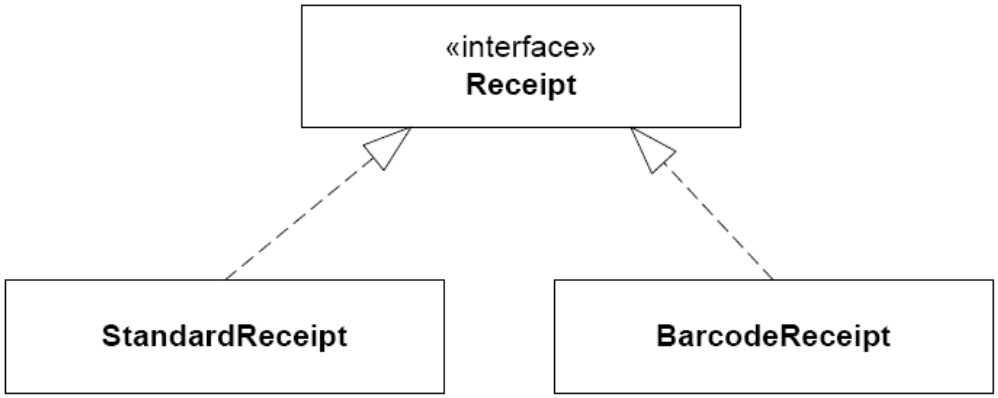
Demo: code-demo/PayStationWithGUI

BetaTown

Change is the only constant in software dev.

Receipts with bar code for easy scanning

```
-----------------------------------------------
-------  P A R K I N G   R E C E I P T  -------
                Value 049 minutes.
              Car parked at 08:06
||  ||||| | || ||| || ||  ||| | || |||| | || ||||
-----------------------------------------------
```



Yet another Variability

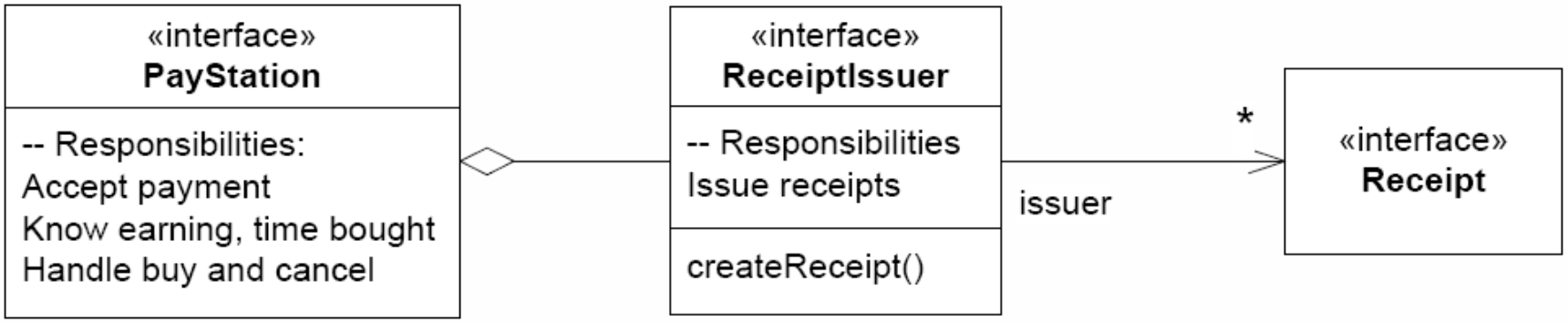
New variability point! Resulting configurations:

	Variability points	
Product	**Rate**	**Receipt**
Alphatown	Linear	Standard
Betatown	Progressive	Barcode
Gammatown	Alternating	Standard

The Compositional Design

Cranking the 3-1-2 blindly

- 3) Identify what varies: *instantiation of receipts*
- 1) Interface express responsibility: ReceiptIssuer
- 2) Compose behavior: delegate to ReceiptIssuer



Trying it out

Quickly add a test:

```
PayStation ps;
/** Fixture for pay station testing. */
@Before
public void setUp() {
  ps = new PayStationImpl( new One2OneRateStrategy(),
                           new StandardReceiptIssuer() );
}
```

Low cohesion: *object creation in two different objects – why not make one cohesive object???*

TDD Principle: **Do Over**

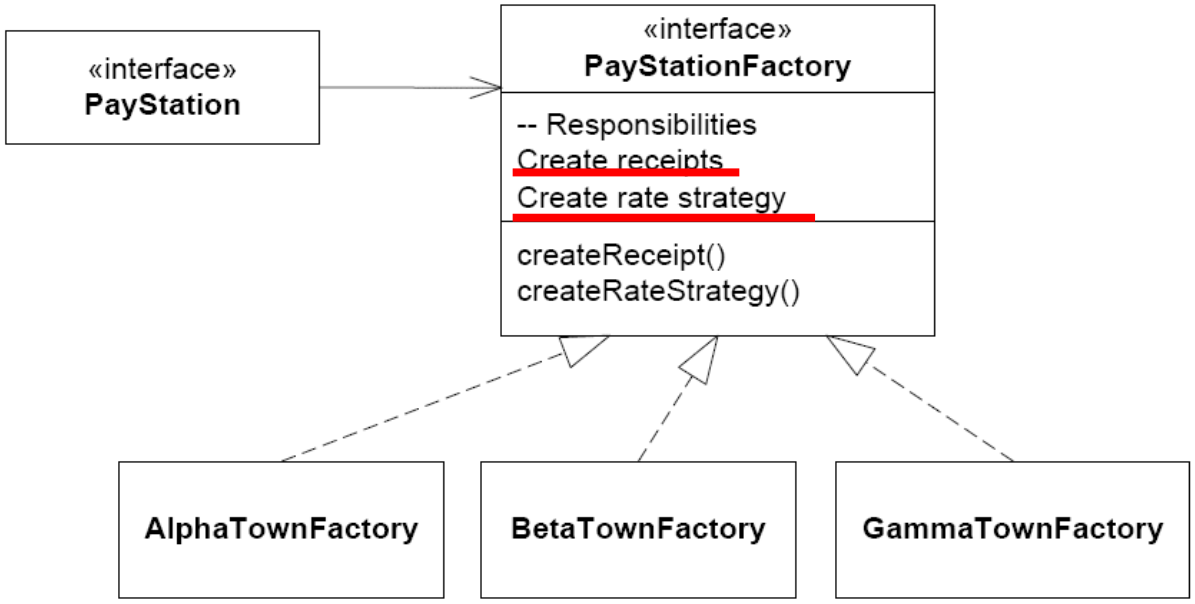
What do you do when you are feeling lost? Throw away the code and start over.

More Cohesive Design

One place to “make configuration objects”

PayStationFactory

- Create receipts
- Create rate strategies



Usage

```
public class PayStationImpl implements PayStation {
  [...]
  /** the strategy for rate calculations */
  private RateStrategy rateStrategy;
  /** the factory that defines strategies */
  private PayStationFactory factory;

  /** Construct a pay station.
      @param factory the factory to produce strategies
  */
  public PayStationImpl( PayStationFactory factory ) {
    this.factory = factory;
    this.rateStrategy = factory.createRateStrategy();
    reset();
  }
  [...]
  public Receipt buy() {
    Receipt r = factory.createReceipt(timeBought);
    reset();
    return r;
  }
  [...]
}
```

```java
public interface PayStationFactory {
  /** Create an instance of the rate strategy to use. */
  public RateStrategy createRateStrategy();

  /** Create an instance of the receipt.
   * @param the number of minutes the receipt represents. */
  public Receipt createReceipt( int parkingTime );
}
```

```java
PayStation ps;
/** Fixture for pay station testing. */
@Before
public void setUp() {
  ps = new PayStationImpl( new TestTownFactory() );
```

Why TestTownFactory()?

TestTownFactory

```
class TestTownFactory implements PayStationFactory {

  public RateStrategy createRateStrategy() {
    return new One2OneRateStrategy();
  }
  public Receipt createReceipt( int parkingTime ) {
    return new StandardReceipt(parkingTime);
  }
```

The Compositional Process

The Process Again Again

- ③ *I identified some behavior, creating objects, that varies between different products.* So far products vary with regards to the types of receipts and the types of rate calculations.
- ① *I expressed the responsibility of creating objects in an interface.* PayStationFactory expressed this reponsibility.
- ② *I let the pay station delegate all creation of objects it needs to the delegate object, namely the factory.* I can define a factory for each product variant (and particular testing variants), and provide the pay station with the factory. The pay station then delegates object creation to the factory instead of doing it itself.

Or…

Definition: **Dependency inversion principle**

High level modules should not depend upon low level modules. Both should depend upon abstractions. Abstractions should not depend upon details. Details should depend upon abstractions. (Martin 1996)

Definition: **Dependency injection**

High-level, common, abstractions should not themselves establish dependencies to low level, implementing, classes, instead the dependencies should be established by injection, that is, by client objects. (Fowler 2004)

Abstract Factory

Deriving it…

3-1-2 has derived yet another design pattern

- An object (factory) whose responsibility it is to create objects (products) that the client need.

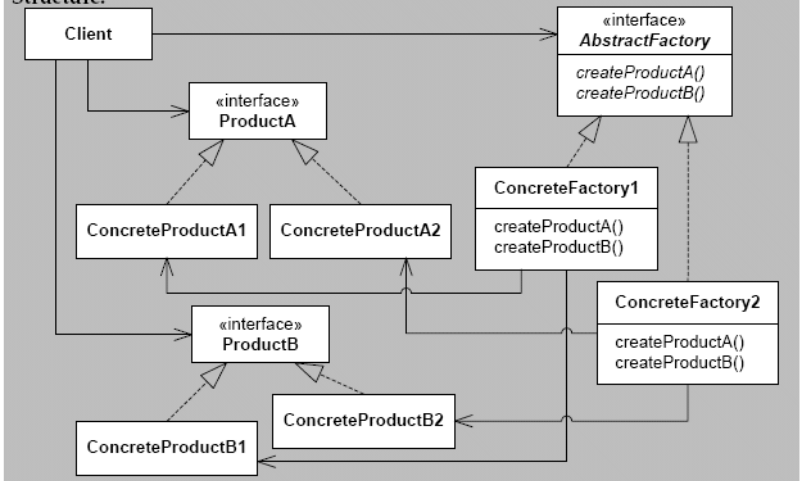
[13.1] Design Pattern: Abstract Factory

Intent Provide an interface for creating families of related or dependent objects without specifying their concrete classes.

Problem Families of related objects need to be instantiated. Product variants need to be consistently configured.

Solution Define an abstraction whose responsibility it is to create families of objects. The client delegates object creation to instances of this abstraction.

Structure:



Roles **Abstract Factory** defines a common interface for object creation. **ProductA** defines the interface of an object, **ConcreteProductA1**, (product A in variant 1) required by the client. **ConcreteFactory1** is responsible for creating **Products** that belong to the variant 1 family of objects that are consistent with each other.

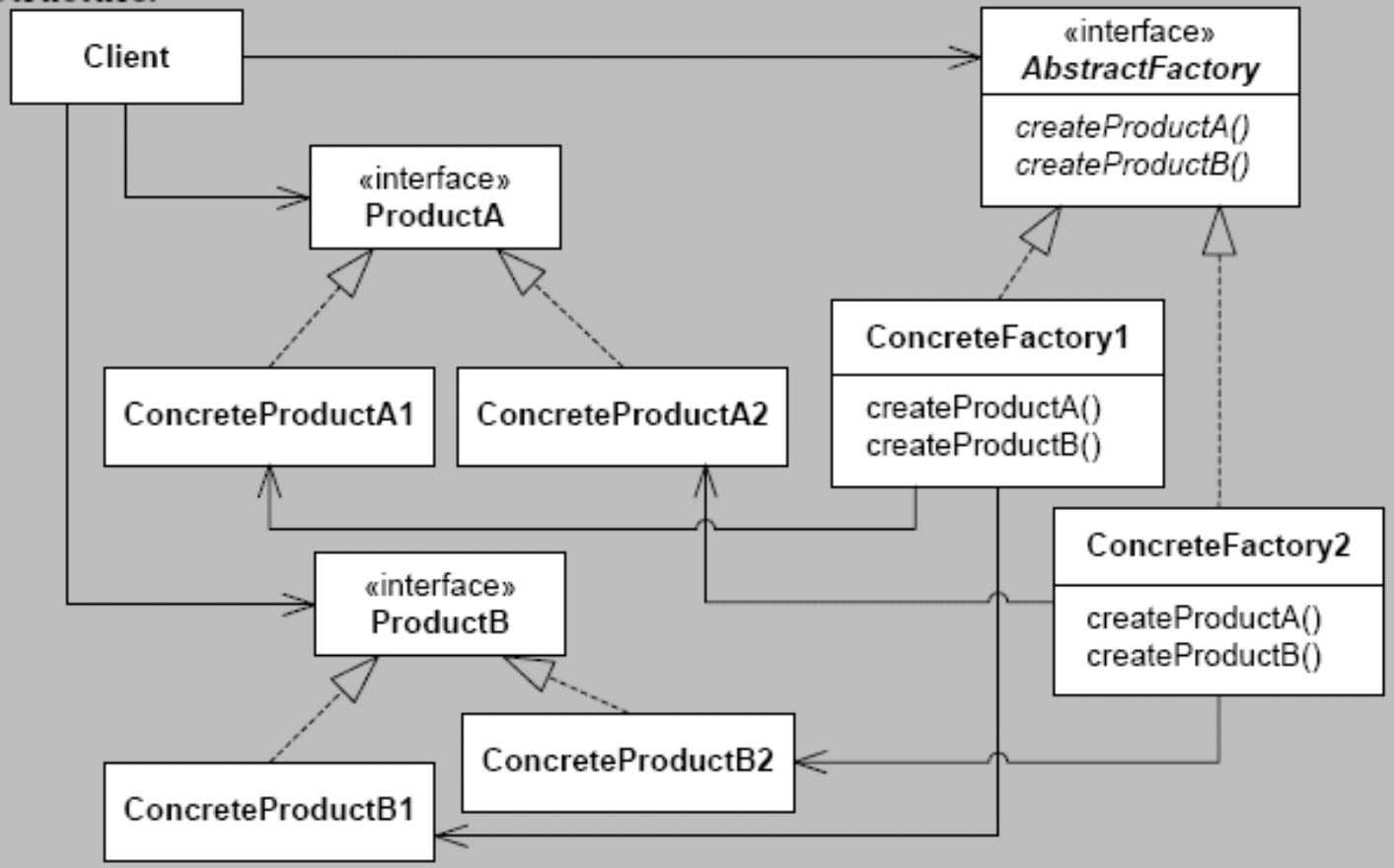
Cost - Benefit *It lowers coupling between client and products* as there are no new statements in the client to create high coupling. *It makes exchanging product families easy* by providing the client with different factories. *It promotes consistency among products* as all instantiation code is within the same class definition that is easy to overview. However, *supporting new kinds of products is difficult*: every new product introduced requires all factories to be changed.

jects without specifying their concrete classes.

Problem Families of related objects need to be instantiated. Product variants need to be consistently configured.

Solution Define an abstraction whose responsibility it is to create families of objects. The client delegates object creation to instances of this abstraction.

Structure:



Roles **Abstract Factory** defines a common interface for object creation. **ProductA** defines the interface of an object, **ConcreteProductA1**, (product A in variant 1) required by the client. **ConcreteFactory1** is responsible

Mandatory Note

Abstract Factory is complex

- Lots of relations
- Easy to get confused or miss the whole idea
- Easy to misimplement a little with BIG consequences

Morale

- Do not underestimate it…