SHARCNET™

Defensive Programming Best Practices

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SHARCNET

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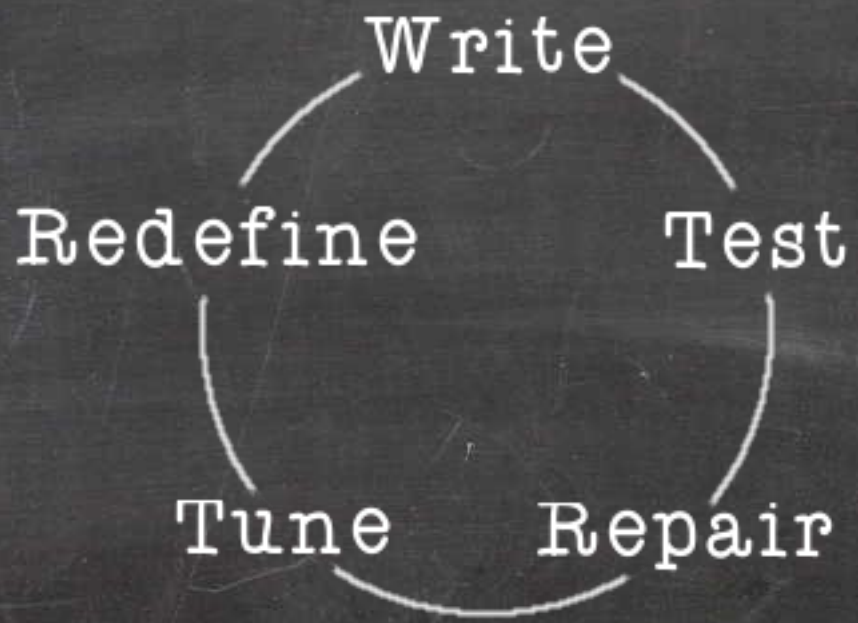
Development Process



Defensive Programming

The philosophy of writing code with the intention of handling unintended, and unforeseen errors, bugs, and circumstances.

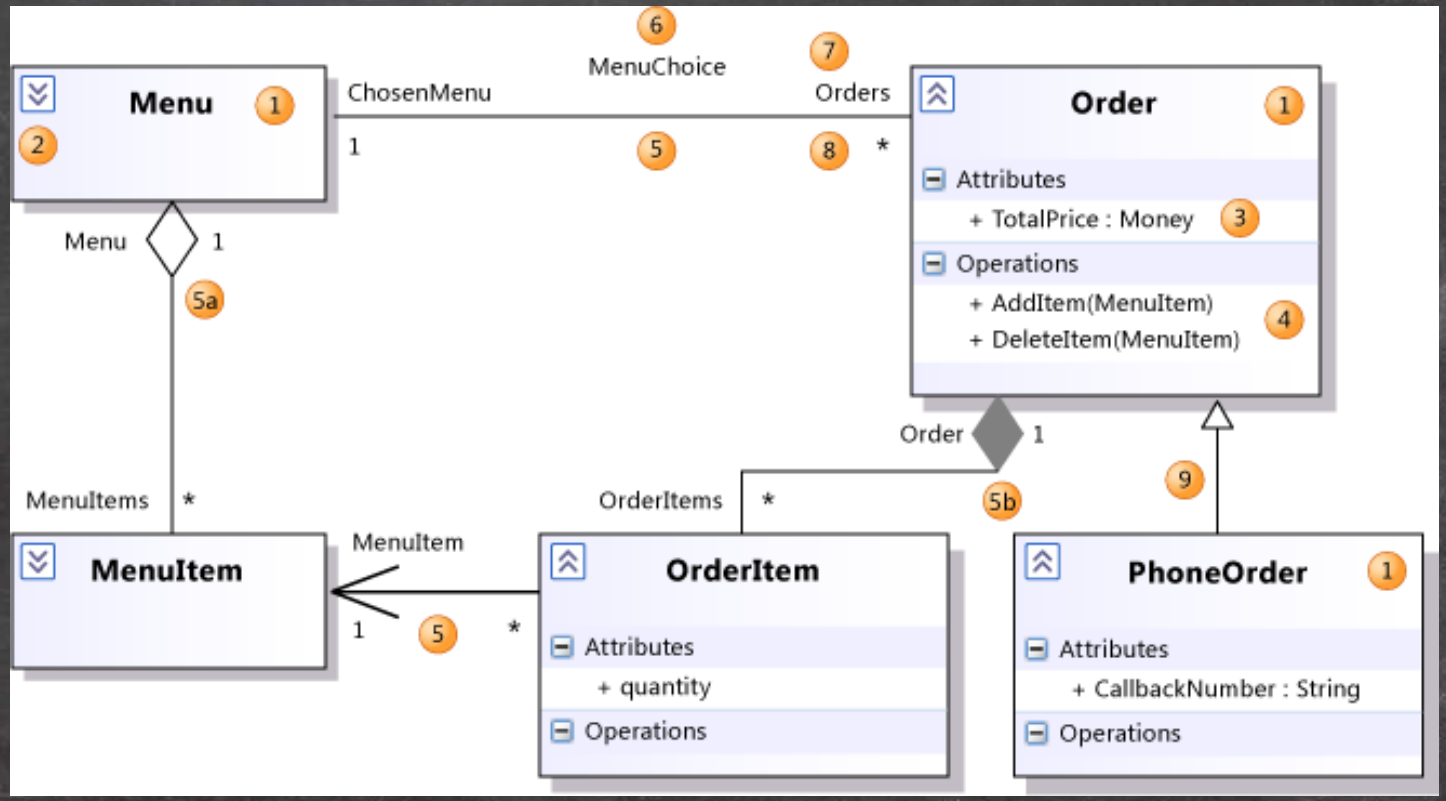
Goals of Defensive Programming

- **Correctness**
- **Clarity**
- **Readability**
- **Bug-Prevention**
- ~~**Speed**~~
- ~~**Early Optimization**~~
- ~~**Cleverness**~~

Part 1 : Object Oriented Programming

- UML
- Abstraction
- Encapsulation
- Inheritance
- Cohesion
- Coupling
- Design Patterns

Unified Modeling Language (UML)

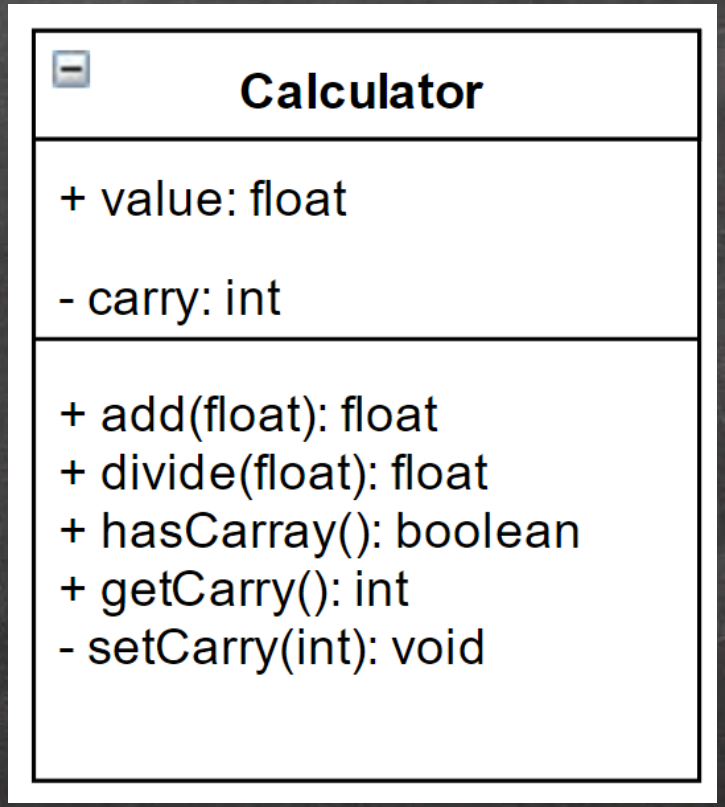


https://msdn.microsoft.com/en-us/library/dd409437.aspx

Object Oriented Programming

- **Abstraction**
- Encapsulation
- Inheritance
- Cohesion
- Coupling
- Design Patterns

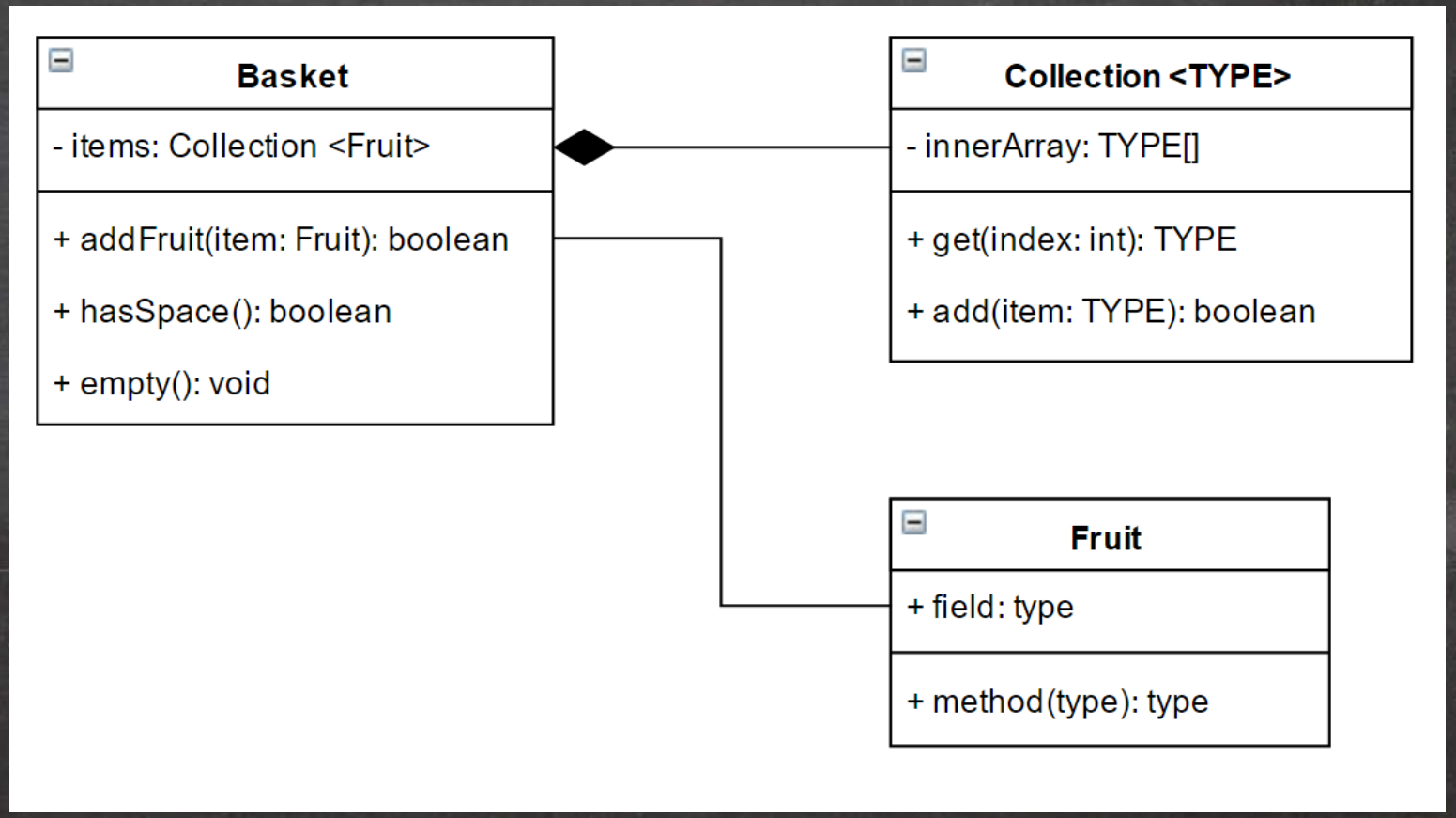
Reduce the complexity of an object by only exposing the relevant properties.



Object Oriented Programming

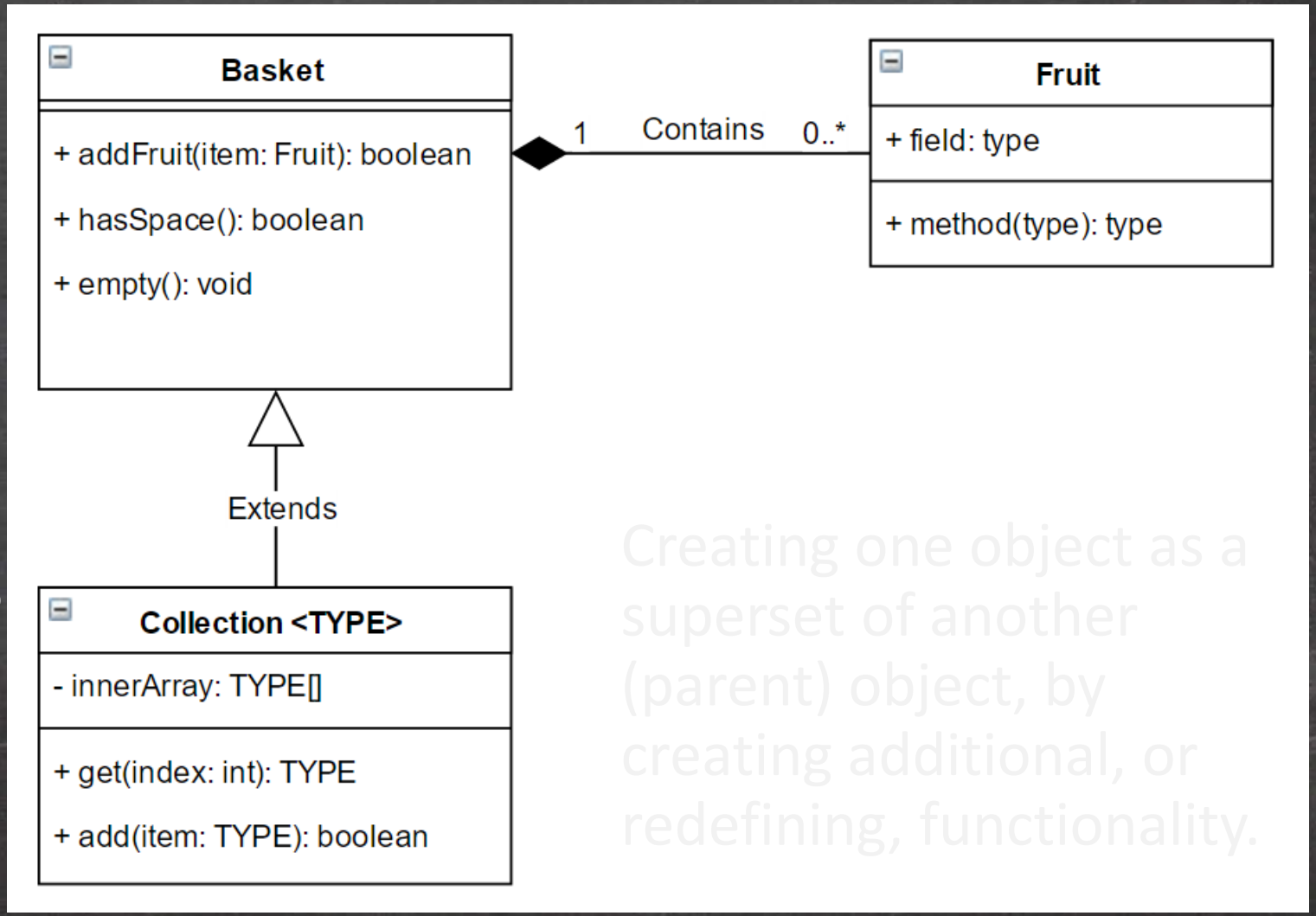
- Abstraction
- **Encapsulation**
- Inheritance
- Cohesion
- Coupling
- Design Patterns

Restricting access to an object's components through the use of methods.



Object Oriented Programming

- Abstraction
- Encapsulation
- Inheritance
- Cohesion
- Coupling
- Design Patterns



Creating one object as a superset of another (parent) object, by creating additional, or redefining, functionality.

Object Oriented Programming

- Abstraction
- Encapsulation
- Inheritance
- **Cohesion**
- Coupling
- Design Patterns

The amount to which the components of an object relate to each other. The goal is to increase cohesion.

Object Oriented Programming

- Abstraction
- Encapsulation
- Inheritance
- Cohesion
- **Coupling**
- Design Patterns

The amount to which two objects are dependent upon each other's behavior. The goal is to reduce coupling.

Object Oriented Programming

- Abstraction
- Encapsulation
- Inheritance
- Cohesion
- Coupling
- **Design Patterns**

Formalized, and recognized practices for solving programming problems or designing an application.

Object Oriented Programming

- Abstraction
- Encapsulation
- Inheritance
- Cohesion
- Coupling
- **Design Patterns**

Structural Patterns	Behavioral Patterns
Composite	Null Object
Builder	Observer
Object Pool	Strategy
Singleton	Iterator

Parallel Patterns	Concurrency Patterns
Farmer-Worker	Thread Pool
Multi-Walk	Mutual Exclusion
Stream	Read-Write Lock
Map-Reduce	Monitor

Part 2 : Style

- modularity; avoid long code blocks
- use consistent naming conventions
- collections over arrays
- use iterators when available

Modularity : Avoid long code blocks

```
public void process (int i){
 /* long detailed comment on what
   * this it statement is doing */
 if (i == 0){
    blah…
    blah…
    blah…
  }
 /* long detailed comment on what
   * this it statement is doing */
  else if (i == 1){
    blah…
    blah…
    blah…
  }
 /* long detailed comment on what
   * this it statement is doing */
  else if (i == 2){
    blah…
    blah…
    blah…
  }
  … more else if statements ad nauseam
```

```
public void process (int i){
  if (i == 0) this.addAll();
  else if (i == 1) this.addSome();
  else if (i == 2) this.addNone();
  else this.addRandom();
}


public void addAll() …
public void addSome() …
public void addNone() …
public void addRandom() …
```

Naming Conventions

A set of rules for naming methods, variables, classes etc. which allows the reader to quickly identify the purpose of the particular identifier.

- letter separated words
- delaminated separated words
- pre/post-fix notation
  - symbol prefix (js __private)
  - word prefix (intSalary)
- rule bases
  - no numbers
  - noun / verb

camelCase
PascalCase
deliminated_words
ALLCAPS
ALL_CAPS_DELIM
intPrefix
$symbolPrefix

Naming Conventions : Readability

```
a = b * c;
pay = wage * hours;
```

```
for (int i = 0; i < n; i++){
    object = array[i];
}
```

```
interface ICollection{…}
abstract ACollection{…}
interface HasContext{…}
```

```
for (int x = 0; x < width; x++)
    for (int y = 0; y < height; y++)
```

```
class{
    setWage(float perHourWage){
        this.wage = wage;
    }

    setHours(int hoursWorked){
        this.hours = hoursWorked;
    }

    float getPay(){
        return wage * hours;
    }
}
```

```
package fruit;

import java.awt.Shape;

public class Fruit implements IFood{
   static final int DISPLAY_RESOLUTION = 640;
   private Flavour flavour;
   private Colour colour;
   private Shape shape;

   public Fruit(){ ... }
   public void ripen(){ ... }
   public void addToBasket(Basket basket){ ... }
}
```

Package

Package Tree

Class/Interface

"Global"

Variable

Method

Multi-word Names

```
// Can you spot the bug?

enum Suit { CLUB, DIAMOND, HEART, SPADE }
enum Rank { ACE, DEUCE, THREE, FOUR, FIVE, SIX, SEVEN, EIGHT,
NINE, TEN, JACK, QUEEN, KING }
...
Collection<Suit> suits = Arrays.asList(Suit.values());
Collection<Rank> ranks = Arrays.asList(Rank.values());

List<Card> deck = new ArrayList<Card>();

for (Iterator<Suit> i = suits.iterator(); i.hasNext(); )
        for (Iterator<Rank> j = ranks.iterator(); j.hasNext();
                deck.add(new Card(i.next(), j.next()));
```

Code snippet from “Essential Java 2nd Edition”

```
// Can you spot the bug?

enum Suit { CLUB, DIAMOND, HEART, SPADE }
enum Rank { ACE, DEUCE, THREE, FOUR, FIVE, SIX, SEVEN, EIGHT,
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Collection<Suit> suits = Arrays.asList(Suit.values());
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for (Iterator<Suit> i = suits.iterator(); i.hasNext(); )
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NINE, TEN, JACK, QUEEN, KING }
...
Collection<Suit> suits = Arrays.asList(Suit.values());
Collection<Rank> ranks = Arrays.asList(Rank.values());

for (Suit suit : suits){
  for (Rank rank : ranks){
    deck.add(new Card(suit, rank));
  }
}
```

Code snippet from “Essential Java 2nd Edition”

Part 3: Patterns and Practices

- exceptional circumstances
- null values
- equals
- interfaces
- strategy pattern
- stateless objects

Exceptional Circumstances

- **Assert** : Things that should never occur; to protect against programming errors (private methods, return value validation).
- **Exception** : Uncommon conditions out of the programmer's control, that the end user may want to know about or requires special handling. (Missing files, dropped connections, etc).
- **Return Value:** Use when a situation isn’t terminal.

NULL is a four letter word!

I call it my billion-dollar mistake ...the invention of the null reference in 1965. At that time, I was designing [ALGOL] ... I couldn't resist the temptation to put in a null reference, simply because it was so easy to implement. This has led to innumerable errors, vulnerabilities, and system crashes, which have probably caused a billion dollars of pain and damage in the last forty years.

- Richard Hoare, the inventor of the NULL reference.

Guidelines to using NULL

- Only use null privately in a class.
- Don't return NULLs.
- Throw an exception when null is passed in.
- Return empty collections (or zero length arrays).
- Return NULL representative objects.

Return Empty Collections

in class
```
public Fruit[] getFruit(){
  if (collection.size() == 0)
  return null;
  …
}
```

in main
```
Fruit f = getFruit();
if (f != null){
   for (Fruit f : getFruit()) {
      [do something]
   }
}
```

in class
```
public Fruit[] getFruit(){
  if (collection.size() == 0)
  return new Fruit[0];
  …
}
```

in main
```
for (Fruit f : getFruit()) {
   [do something]
}
```

Single Instance

```
class Basket{
   private ArrayList <Fruit> fruits;
   public Fruit getFruit(){
      if (fruits.size() == 0)
         return null;
      else
         return fruits.remove(0);
   }
}
```

Single Instance Fixed

```
class Basket{
   private ArrayList <Fruit> fruits;

   public boolean hasFruit(){
      return fruits.size() > 0;
   }

   public Fruit getFruit(){
      if (fruits.size() == 0) throw new NullPointerException();
      else return fruits.remove(0);
   }
}
```

NULL misrepresenting errors

```
Fruit aPieceOfFruit = fruitBasket.getFruit();
[do some stuff]
aPieceOfFruit.eat(); /* throws exception */
```

NULL misrepresenting errors

```
Fruit fruit = basket.getFruit(); /* throws exception */
[do some stuff]
aPieceOfFruit.eat();
```

Interfaces

```
interface IFood {
    Flavour getFlavour();
    Size getSize();
    void setPortions(int i);
    int getPortions();

    default void bite(){
        this.setPortions(this.getPortions() - 1);
    }
}
```

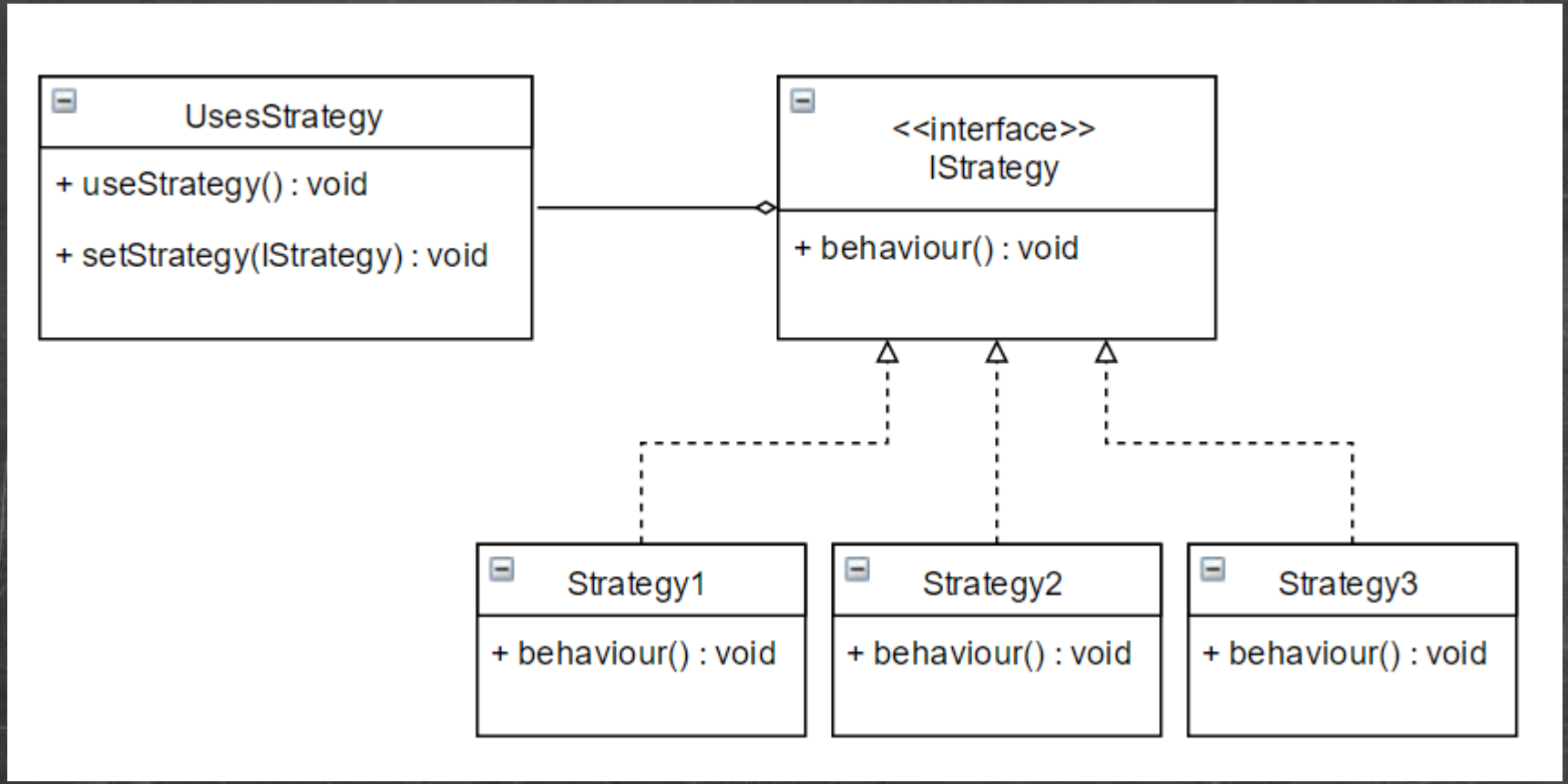
Code to the Interface

```
Class Bucket{
        private ArrayList myList= new ArrayList();
}

Class Bucket{
        private List myList = new ArrayList();
}

Class Bucket{
        private List myList = new TreeList();
}
```

Strategy Pattern



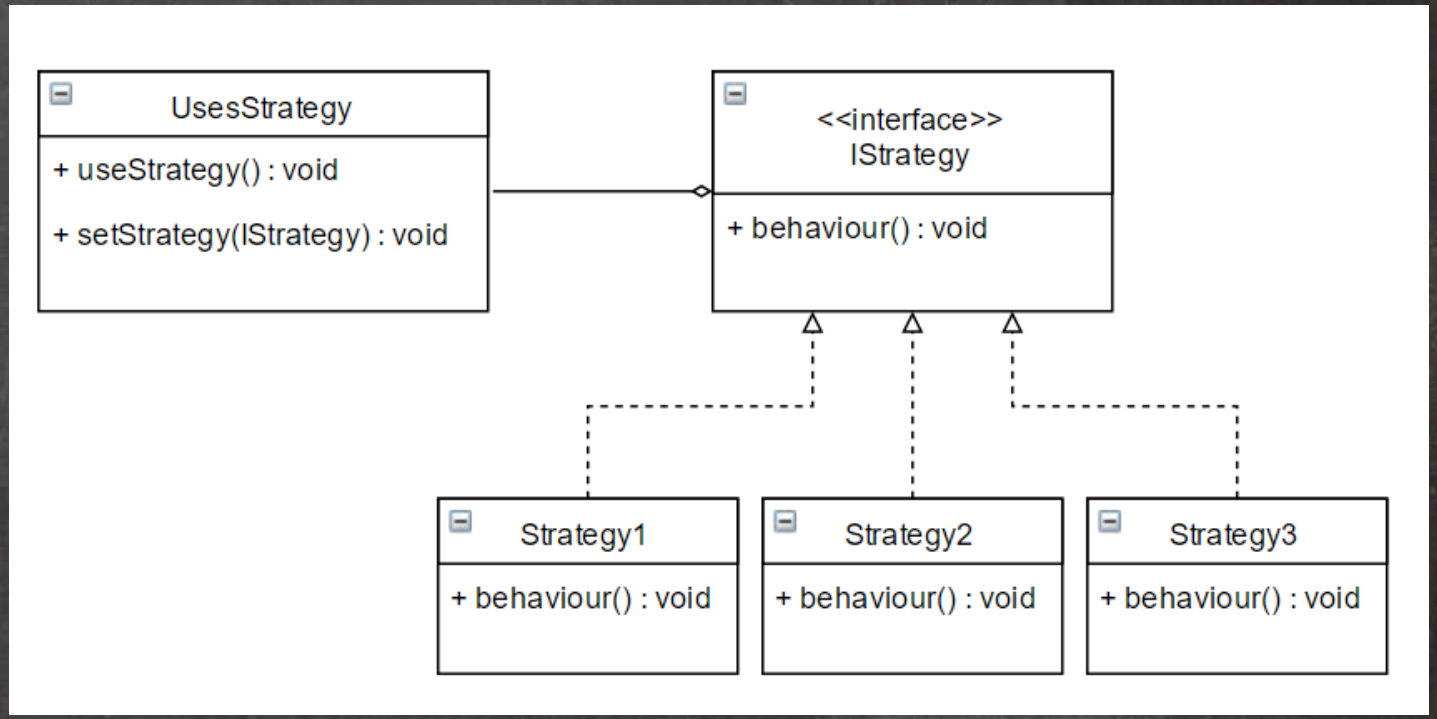
Strategy Pattern

```
interface IStrategy{
	public void behaviour();
}

class Strategy1 implements IStrategy{
	public void behaviour(){…}
}

class Strategy2 implements IStrategy{
	public void behaviour(){…}
}

class Strategy3 implements IStrategy{
	public void behaviour(){…}
}
```

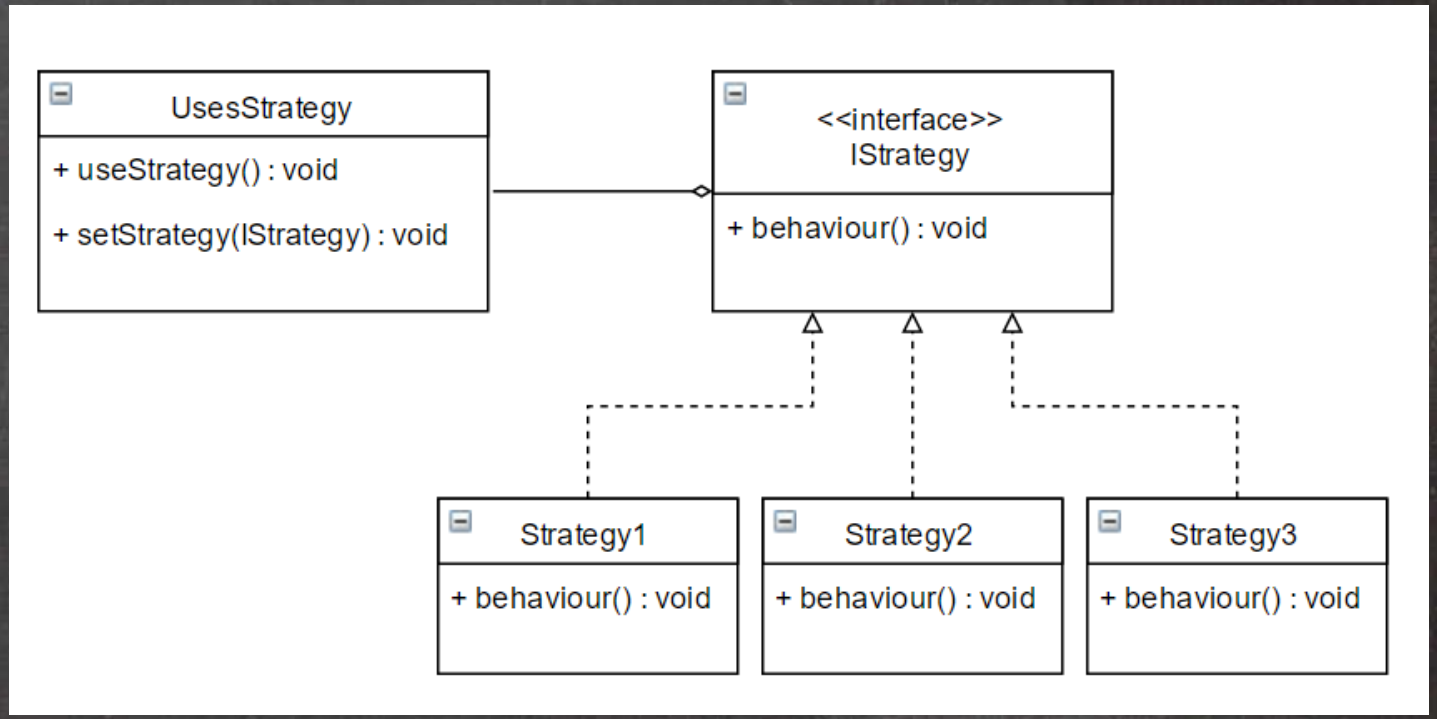


Strategy Pattern

```
class UsesStrategy {
    private IStrategy strategy;

    public void setStrategy(IStrategy strategy){
        this.strategy = strategy;
    }

    public void useStrategy(){
        … stuff …
        useStrategy();
        … stuff …
    }
}
```



Immutable Pattern

```
public interface ImmutableFruit {
   Flavour getFlavour();
   Colour getColour();
   Shape getShape();
}
```

```
public class Fruit
implements ImmutableFruit{

   private Flavour flavour;
   private Colour colour;
   private final Shape shape;

   public Flavour getFlavour() {...}
   public Colour getColour() {...}
   public Shape getShape() {...}

   public Fruit(){ ... }

   public void ripen(){ ... }
}
```

Citations

- Collected Java Practices,. [online], http://www.javapractices.com (accessed 2015)

- Bloch, J. "Effective Java, 2nd edn. The Java Series." (2008).