

# Tecniche di Progettazione: Design Patterns

GoF: Strategy

# A case study

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- ▶ Fox Machine is a company that sells printers and gives discounts to clients.
- ▶ But there are many kinds of discount calculation methods such as: 5% off, reduce a fixed amount, no discount at all, etc. Now Fox Machine asks you to develop a sales management system, they want you to design a schema to calculate the discount when selling printers. Your design should be capable of selecting the discount calculation methods flexibly (even selling the same kind of printer).
- ▶ Further more, when they need new discount calculation methods or want to modify old methods, it should be very easy and will not affect the existing system.

## Recall some OO design principles

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- ▶ “Identify what vary and encapsulate them, so that later you can alter or extend the parts that vary without affecting those that don’t”;
- ▶ “Program to an interface, not an implementation”;
- ▶ “Favor composition over inheritance”.

# Example

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- ▶ The MyArray class represents vectors of numbers
- ▶ One of its methods print the array, in two formats:
  - ▶ MathFormat (es. {12, -7, 3, ...})
  - ▶ StandardFormat (es. ar[0]\_12, ar[1]\_-7, ar[2]\_3, ... )
- ▶ In the future these formats may be substituted by different ones....
  
- ▶ Problem:
  - ▶ How to isolate the algorithm used to format the array contents, so that it can vary independently of the other methods of the class?
  
  - ▶

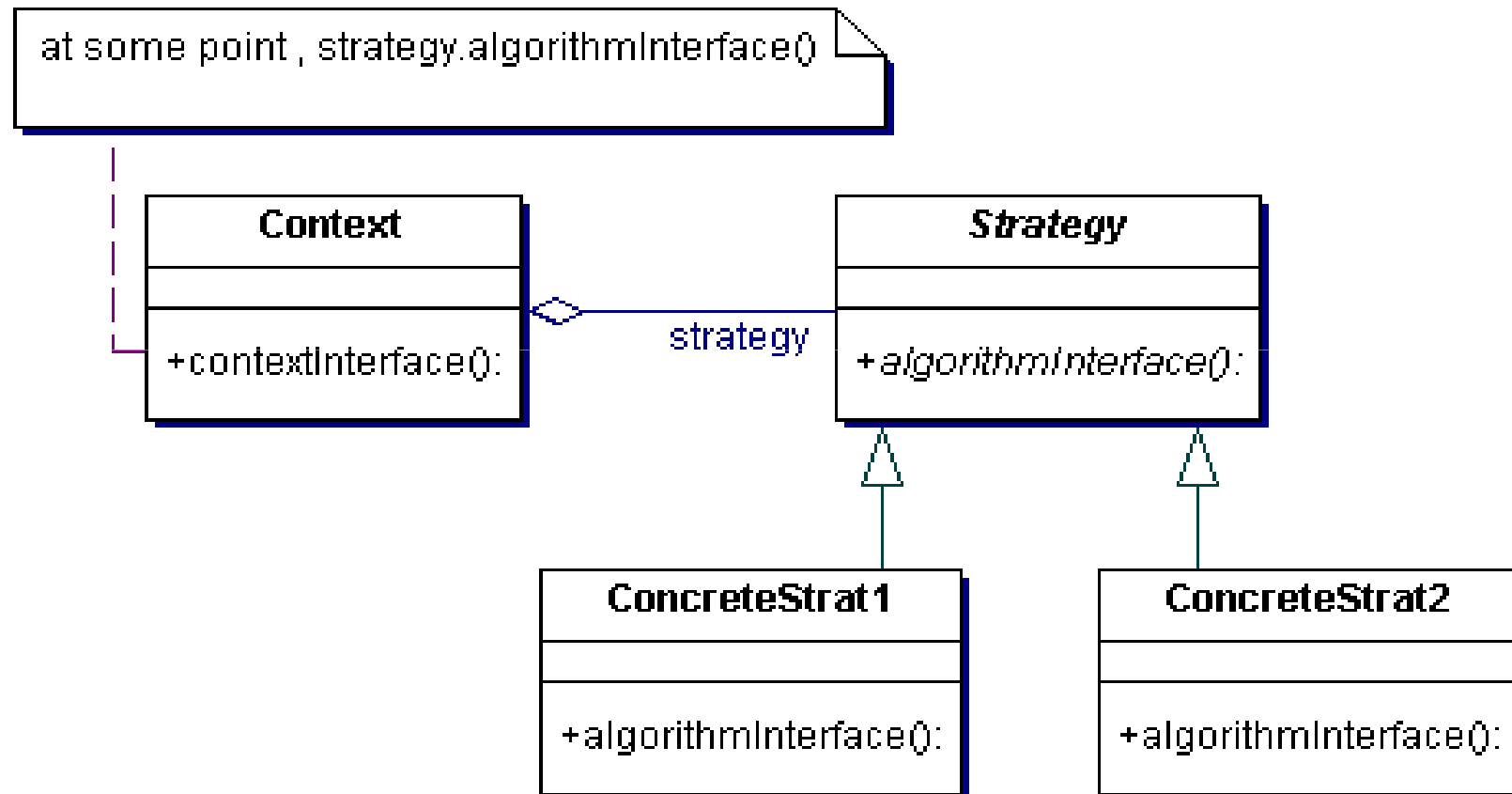
# Strategy

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- ▶ Define a family of algorithms, encapsulate each one, and make them interchangeable. Strategy lets the algorithm vary independently from clients that use it.
- ▶ A program may have to supply several variations of an algorithm or of a behaviour.
- ▶ Solution:
  - ▶ These variations are encapsulated in separate classes
  - ▶ There is a uniform access to them

# Strategy: structure

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# Strategy: participants

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## ▶ Strategy

- ▶ Dichiarare l'interfaccia comune degli algoritmi, usati da Context

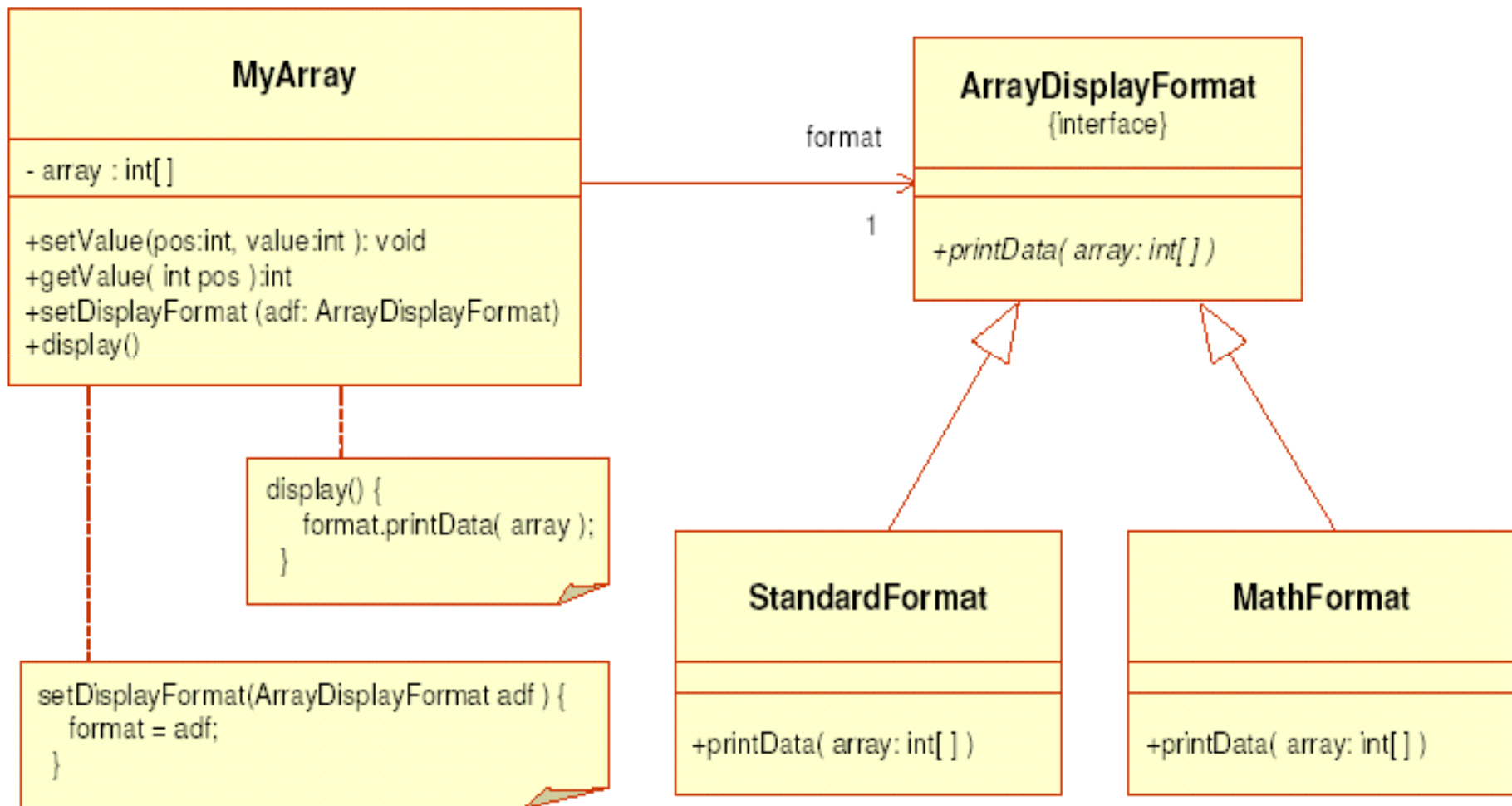
## ▶ ConcreteStrategy

- ▶ Realizza gli algoritmi, con interfaccia Strategy

## ▶ Context

- ▶ Definisce l'interfaccia al cliente
- ▶ Fa riferimento a un oggetto ConcreteStrategy, visto come Strategy
- ▶ Può offrire accesso al proprio stato all'oggetto di tipo Strategy, attraverso un'interfaccia
  - ▶ (anziché passarli come argomenti)

# Solution





# Context

```
public class MyArray {  
    private int[] array;  
    private int size;  
    ArrayDisplayFormat format;  
  
    public MyArray( int size ) {  
        array = new int[ size ];  
    }  
  
    public void setValue( int pos, int value ) {  
        array[pos] = value;  
    }  
  
    public int getValue( int pos ) {  
        return array[pos];  
    }  
  
    public int getLength( int pos ) {  
        return array.length;  
    }  
  
    public void setDisplayFormat( ArrayDisplayFormat adf ) {  
        format = adf;  
    }  
  
    public void display() {  
        format.printData( array );  
    }  
}
```

# The interface (strategy)

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```
public interface ArrayDisplayFormat {  
    public void printData( int[] arr );  
  
}
```

# First concrete strategy

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```
public class StandardFormat implements ArrayDisplayFormat {  
  
    public void printData( int[] arr ) {  
        System.out.print( "{ " );  
        for( int i=0; i < arr.length-1 ; i++ )  
            System.out.print( arr[i] + ", " );  
        System.out.println( arr[arr.length-1] + " }" );  
  
    }  
}
```

## Second concrete strategy

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```
public class MathFormat implements ArrayDisplayFormat {  
  
    public void printData( int[] arr ) {  
        for(int i=0; i < arr.length ; i++ )  
            System.out.println( "Arr[ " + i + " ] = " + arr[i] );  
    }  
}
```

# The client

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```
public class StrategyExample {  
  
    public static void main (String[] arg) {  
  
        MyArray m = new MyArray( 10 );  
        m.setValue( 1 , 6 );  
        m.setValue( 0 , 8 );  
        m.setValue( 4 , 1 );  
        m.setValue( 9 , 7 );  
        System.out.println("This is the array in 'standard' format");  
        m.setDisplayFormat( new StandardFormat() );  
        m.display();  
        System.out.println("This is the array in 'math' format:");  
        m.setDisplayFormat( new MathFormat() );  
        m.display();  
    }  
}
```

- ▶ È il cliente che crea e passa un oggetto ConcreteStrategy al Context
- ▶ Da quel momento interagisce solo con Context

# The result

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```
C: \Design Patterns\Behavioral\Strategy>java StrategyExample
```

```
This is the array in 'standard' format :
```

```
{ 8, 6, 0, 0, 1, 0, 0, 0, 0, 7 }
```

```
This is the array in 'math' format:
```

```
Arr[ 0 ] = 8
```

```
Arr[ 1 ] = 6
```

```
Arr[ 2 ] = 0
```

```
Arr[ 3 ] = 0
```

```
Arr[ 4 ] = 1
```

```
Arr[ 5 ] = 0
```

```
Arr[ 6 ] = 0
```

```
Arr[ 7 ] = 0
```

```
Arr[ 8 ] = 0
```

```
Arr[ 9 ] = 7
```

# Applicability

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- ▶ **Use the Strategy pattern whenever:**
  - ▶ Many related classes differ only in their behavior
  - ▶ You need different variants of an algorithm
  - ▶ An algorithm uses data that clients shouldn't know about. Use the Strategy pattern to avoid exposing complex, algorithm-specific data structures.
  - ▶ A class defines many behaviors, and these appear as multiple conditional statements in its operations. Instead of many conditionals, move related conditional branches into their own Strategy class.

# Discussion

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## ▶ Benefits

- ▶ Provides an alternative to subclassing the Context class to get a variety of algorithms or behaviors
- ▶ Eliminates large conditional statements
- ▶ Provides a choice of implementations for the same behavior

## ▶ Liabilities

- ▶ Increases the number of objects
- ▶ All algorithms must use the same Strategy interface



## Discussion (cont'd)

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- ▶ Different ConcreteStrategy may need different data.
- ▶ Most probably some ConcreteStrategy will not use all the data passed through the generic interface
  - ▶ Hence: the context create and initializes parameters that will never be used by anybody
  - ▶ When this is a problem: stronger coupling between ConcreteStrategy and Context (the former accessing the latter)

# Strategy Pattern Example: SORT

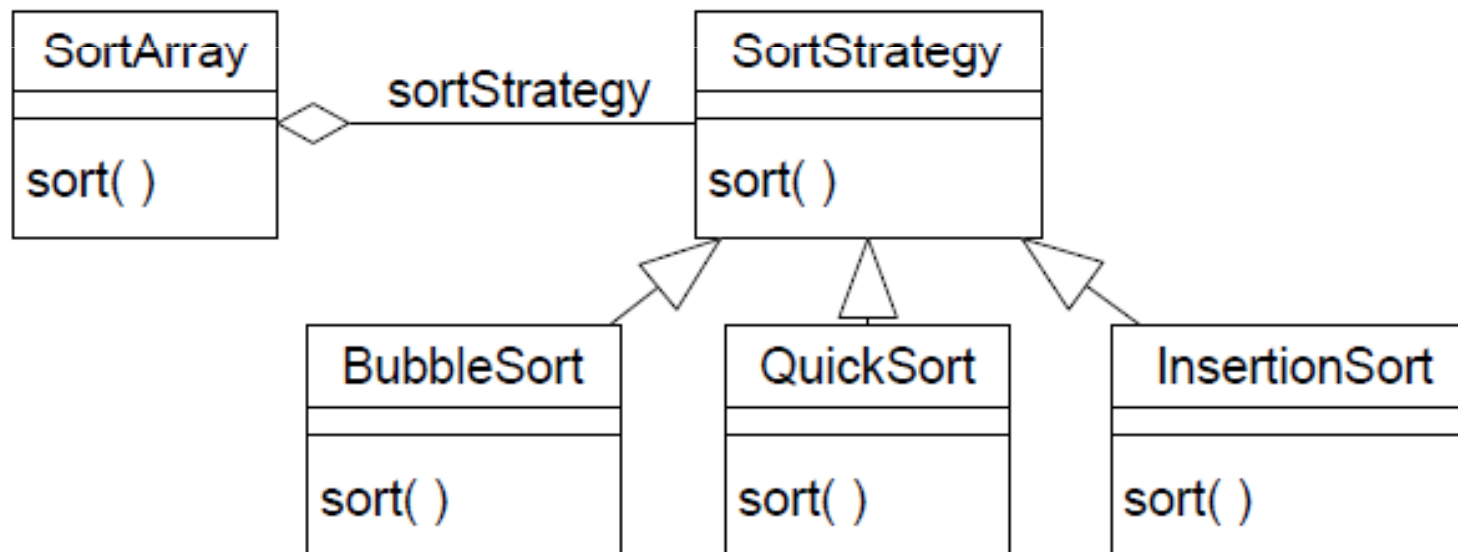
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▶ **Problem:**

- ▶ A class wants to decide at run-time what algorithm it should use to sort an array. Many different sort algorithms are already available.

▶ **Solution**

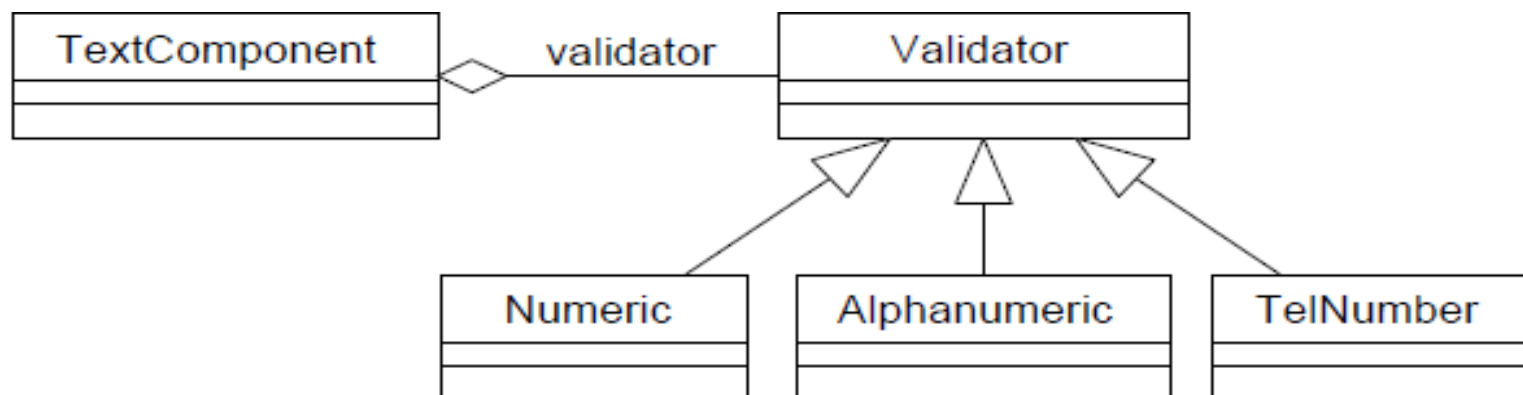
- ▶ Encapsulate the different sort algorithms using the Strategy pattern



# Strategy Pattern Example: GUI

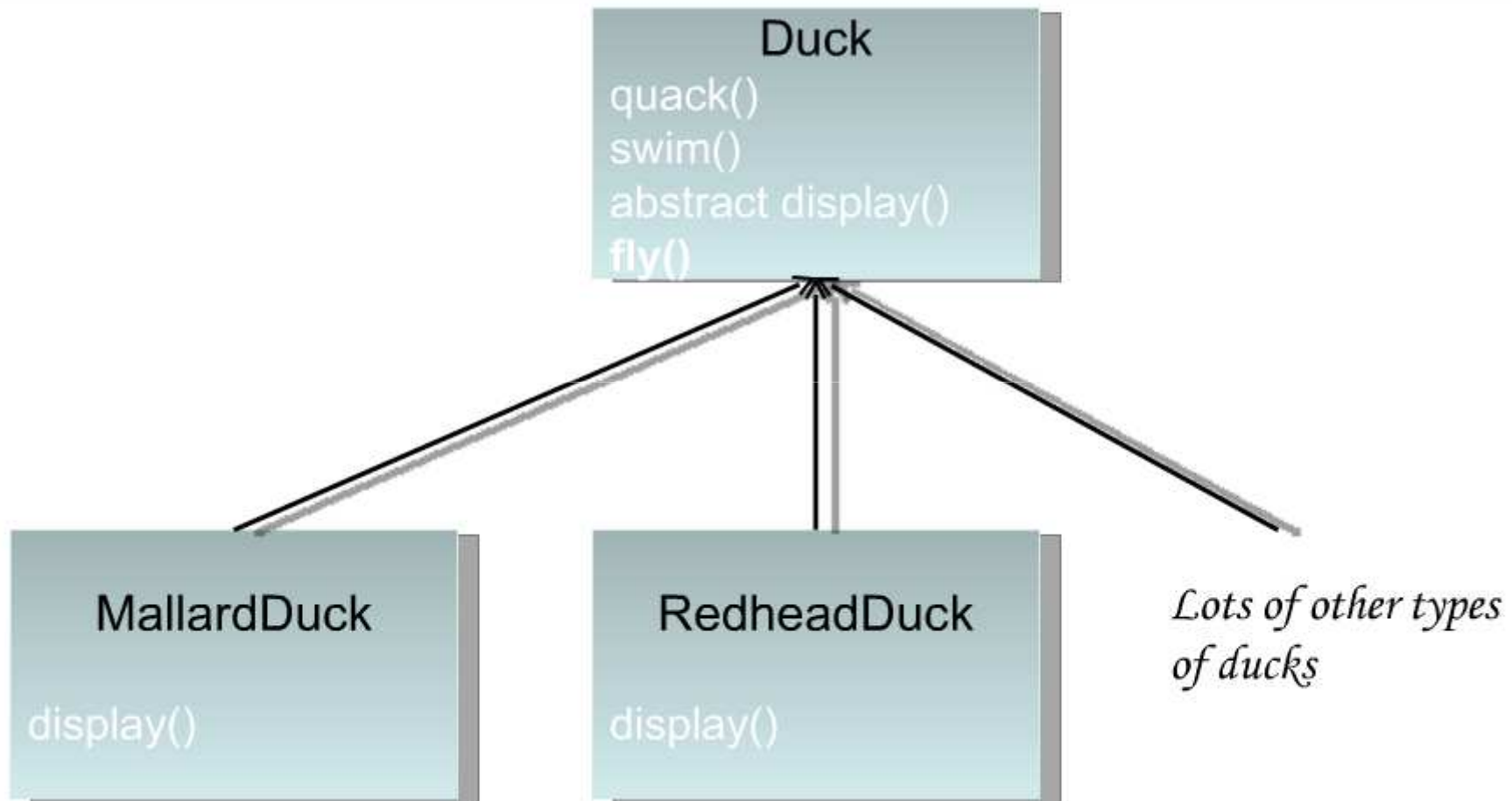
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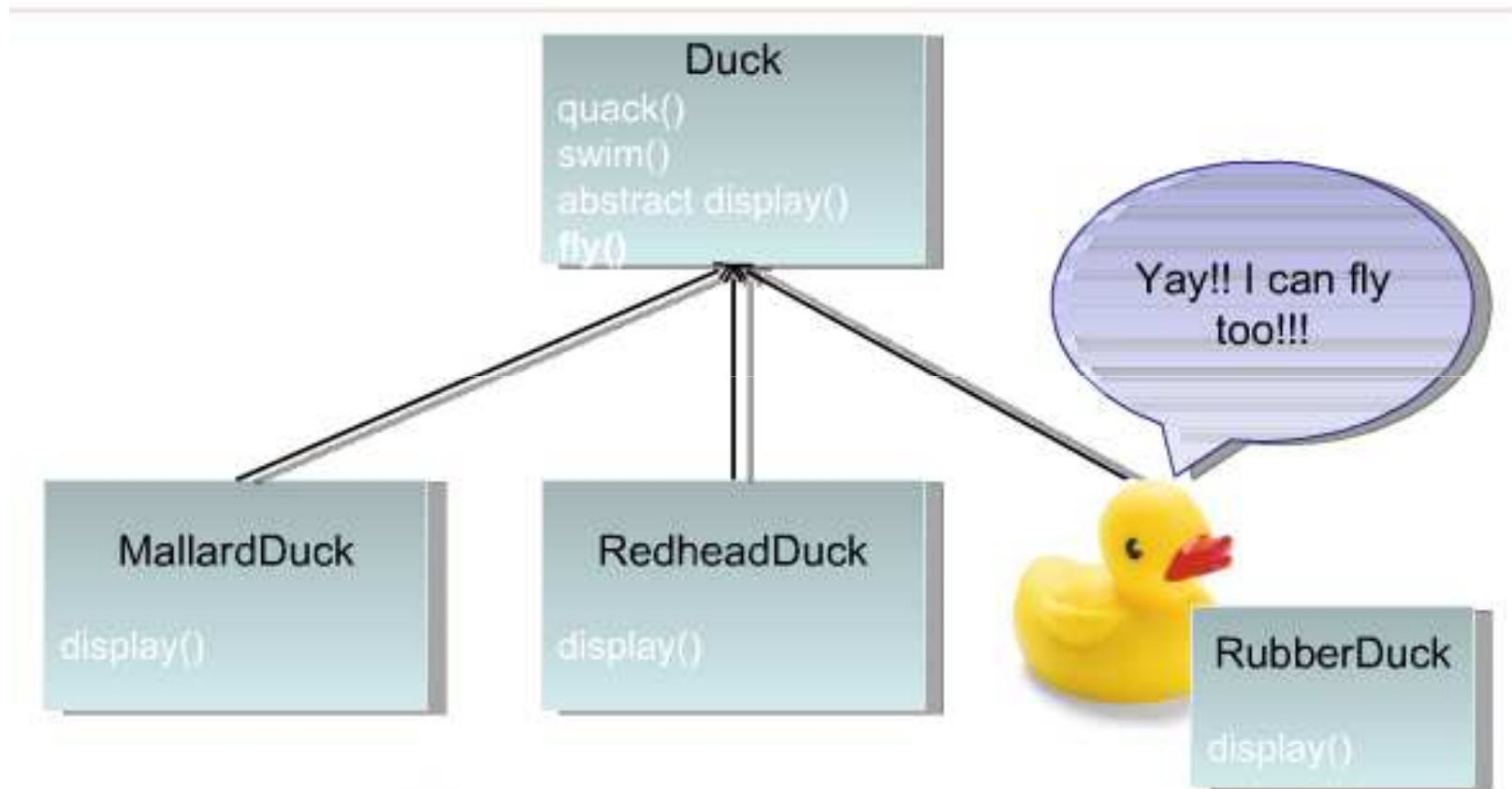
- ▶ A GUI text component object wants to decide at runtime what strategy it should use to validate user input. Many different validation strategies are possible: numeric fields, alphanumeric fields, telephone-number fields, etc.
- ▶ Solution
  - ▶ Encapsulate the different input validation strategies using the Strategy pattern
- ▶ This is the technique used by the Java Swing GUI text components. Every text component has a reference to a document model which provides the required user input validation strategy.



# Strategy pattern: the duck

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# First solution

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- ▶ Override fly()
- ▶ Class Rubberduck{

```
    fly() {  
        \\ do nothing  
    }  
    quack(){  
        \\ override to squeak  
    }  
}
```
- ▶ **PROBLEM:** subclassing when only part of the behaviour is inherited
  - ▶ All time a new duck is added, the designer has to check if methods fly and quack have to be overriden

## Second solution

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# <<Interfaces>> !!!

Yes!!! That's it! I make an IFlyable interface and RubberDuck doesn't get to implement it...

```
MallardDuck
<<IFlyable>>
display()
```

```
RedheadDuck
<<IFlyable>>
display()
```

```
RubberDuck
//You can't fly!
display()
```

They can't see me happy 😞

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I... I... I...  
I have a Question!  
SimCorp simulates 50 ducks... are you saying  
you are going to write 50 fly methods? What if  
there is a change in flying style and it effects  
20 ducks... will all 20 ducks change?  
I am losing money you know...





## I thought she was non-technical...

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- Well here is my situation
- I can't put the fly() method in the base class
- If I use interface, I can't reuse code
- Alright, so this calls for a dependency split
- Flying is a behavior and should be separate from the Duck object
- Flying behaviors could be reused on different objects
- Different ducks could fly in different ways

# Strategy

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