DESIGN PATTERNS

Course 2

CONTENT

- Fundamental Principles of OOP
  - Encapsulation
  - Inheritance
  - Abstraction
  - Polymorphism
  - [Exception Handling]
- Fundamental Patterns
  - Inheritance
  - Delegation
  - Interface
  - Abstract superclass
  - Inheritance and abstract superclass
  - Immutable objects
  - Marker interface
- OOD key principles
  - SRP – Single Responsibility Principle
  - OCP - Open Close Principle
  - LSP – Liskov Substitution Principle
  - ISP – Interface Segmentation Principle
  - DIP – Dependency Inversion Principle
  - DRY – Don't Repeat Yourself

FUNDAMENTALS PRINCIPLES OF OOP

- Objects
  - Describe characteristics (properties) and behavior (methods) of real life objects
- Object Oriented language
  - Encapsulation
    - **hide unnecessary details** and provide a clear and simple interface for working with them
  - Inheritance
    - improve code readability and enable the reuse of functionality
  - Abstraction
    - deal with objects considering their important characteristics and ignore all other details
  - Polymorphism
    - how to work in the same manner with different objects
  - [Error handling]
    - how to work in the same manner with different objects

FUNDAMENTALS PRINCIPLES OF OOP. ABSTRACTION

- Abstraction
  - Problem -> Model
- Model
  - Dates
  - Operations
  - A simplification with a scope of a problem
    - Simple model => accessible code
  - Model Views
    - A view for system major parts interaction
    - A view of system details
    - A view from user point of view
    - …
  - Common notation
    - Unified Modeling Model (UML)

Example:

- How does a *person* see a computer?
  - Child: a device for gaming
  - Electronics: an assembly of circuits and transistors
  - Programmers: an environment for developing tools

FUNDAMENTALS PRINCIPLES OF OOP. ENCAPSULATION

- Hide unnecessary the properties and behavior of objects
- Reduce the necessary knowledge about a class, in order to user it
  - In many cases the programmer does not need to know implementation details of a class, if the class offers the desired behavior

```
class WithoutEncapsulationOrInformationHide
{
public const int STATUS_ACTIVE = 0;
public const int STATUS_HALTED = 1;
public int status = STATUS_ACTIVE;
};
```

```
class EncapsulationWithoutInformationHide
{
public const int STATUS_ACTIVE = 0;
public const int STATUS_HALTED = 1;
private int status = STATUS_ACTIVE;
public int getStatus() {
   return status;
  }
};
```

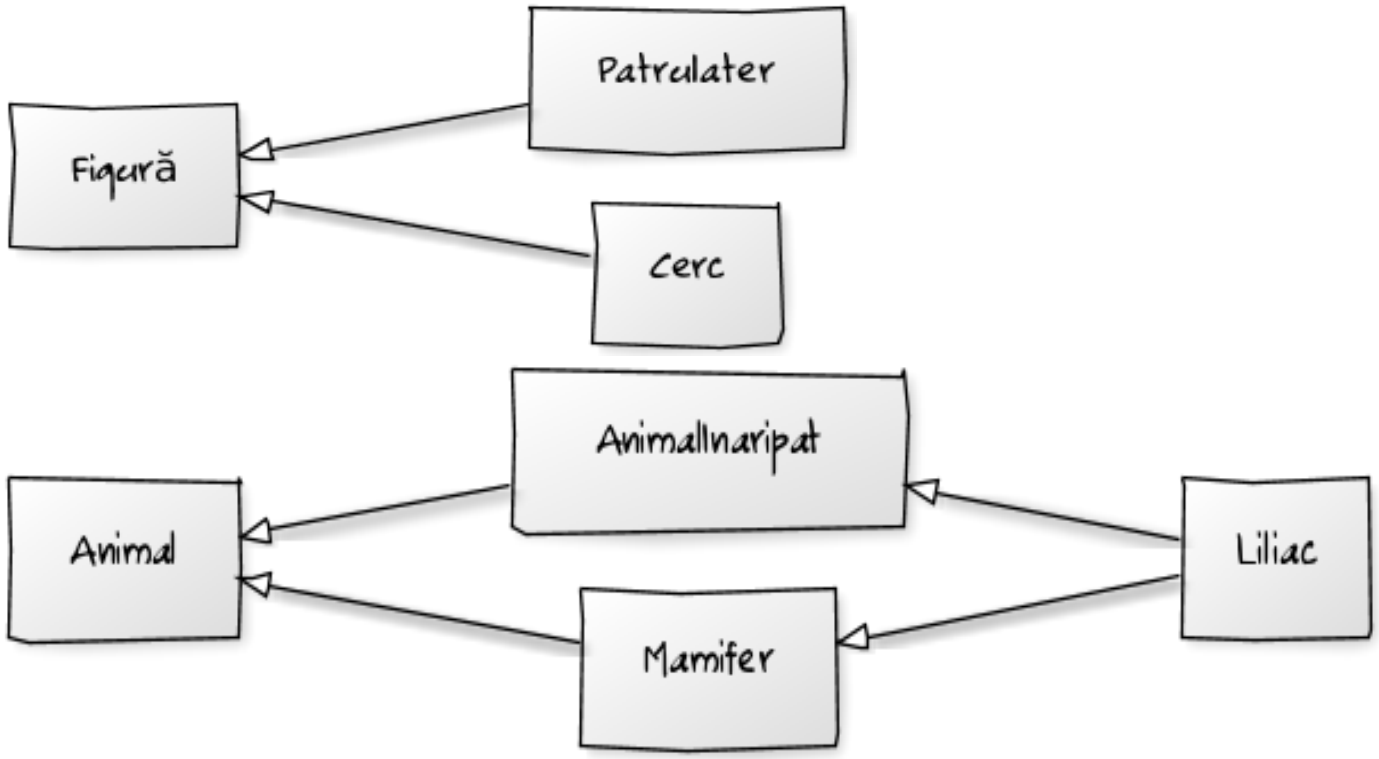
```
class EncapsulationAndInformationHide
{
public const int STATUS_ACTIVE = 0;
public const int STATUS_HALTED = 1;
private int status = STATUS_ACTIVE;
private int getStatus() {
   return status;
  }
public boolean isActive() {
     return getStatus() == STATUS_ACTIVE;
  }
};
```

FUNDAMENTALS PRINCIPLES OF OOP. INHERITANCE

- Inheritance is a mechanism which allows a class A to inherit members (data and functions) of a class B. We say "A inherits from B". Objects of class A thus have access to members of class B without the need to redefine them.

- Terminology
  - Base class
    - The class that is inherited
  - Derived class
    - A specialization of base class
  - Kind-of relation
    - Class level (Circle is a kind-of Shape)
  - Is-a relation
    - Object level (The object circle1 is-a shape.)

- Types of inheritance
  - Simple
    - One base class
  - Multiple
    - Multiple base classes



FUNDAMENTALS PRINCIPLES OF OOP. POLYMORPHISM

- Polymorphism the ability to use a thing in different ways
  - Run-time
    - Inheritance
    - Virtual functions (C++)
    - Generics (Java)
  - Compile-time
    - Templates (C++)
  - Ad-hoc
    - Operator overloading (in C++)
  - Parametric
    - Casting

FUNDAMENTALS PRINCIPLES OF OOP. ERROR HANDELING

- An exception is an error that appears at run-time.
- Examples
  - Out of memory
  - File already opened
  - Null pointer exception
- Variants to resolve such situations
  - Custom mechanism
    - Program stops -> unacceptable solution
    - Return of an error code -> the state of the program has to test the error code returned
    - A function that is called each time an error occurs -> no control over the caller
  - Using language mechanism of handling exceptions

FUNDAMENTAL PATTERNS

- Fundamentals patterns
  - Patterns already found permanent in modern programming languages
  - Not classified in other categories
- Fundamentals patterns types
  - Inheritance
  - Delegation
  - Interface
  - Abstract superclass
  - Inheritance and abstract superclass
  - Immutable objects
  - Marker interface

FUNDAMENTALS PATTERNS. DELEGATE

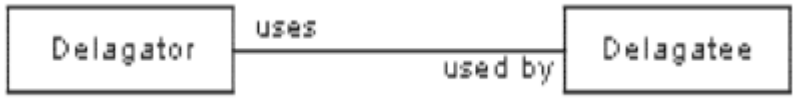
Intent:

- Delegation allows objects to share behavior without using inheritance and without duplicating code

Solution:

- Delegation is a way of reusing and extending the behavior of a class. It works writing a new class that incorporates the functionality of the original class by using an instance of the original class and calling its methods.

Consequences:



- Behavior can be changed at run-time (comparing to inheritance that is static)
- The 'delegate' is hidden to delegator's clients
- More difficult to implement comparing to inheritance

FUNDAMENTAL PATTERNS. INTERFACE

Name: Interface

Intent:

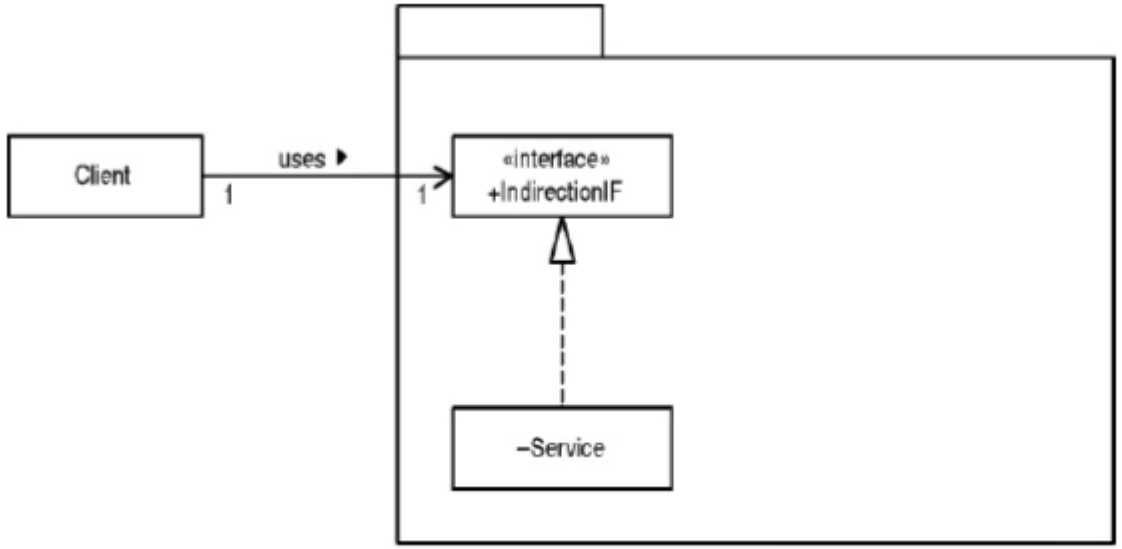
- Classes change messages between them
- The implementation must be switched at run time
- At design-time when the implementation used at compile time is not known

Definition

- Decouples the service from its clients

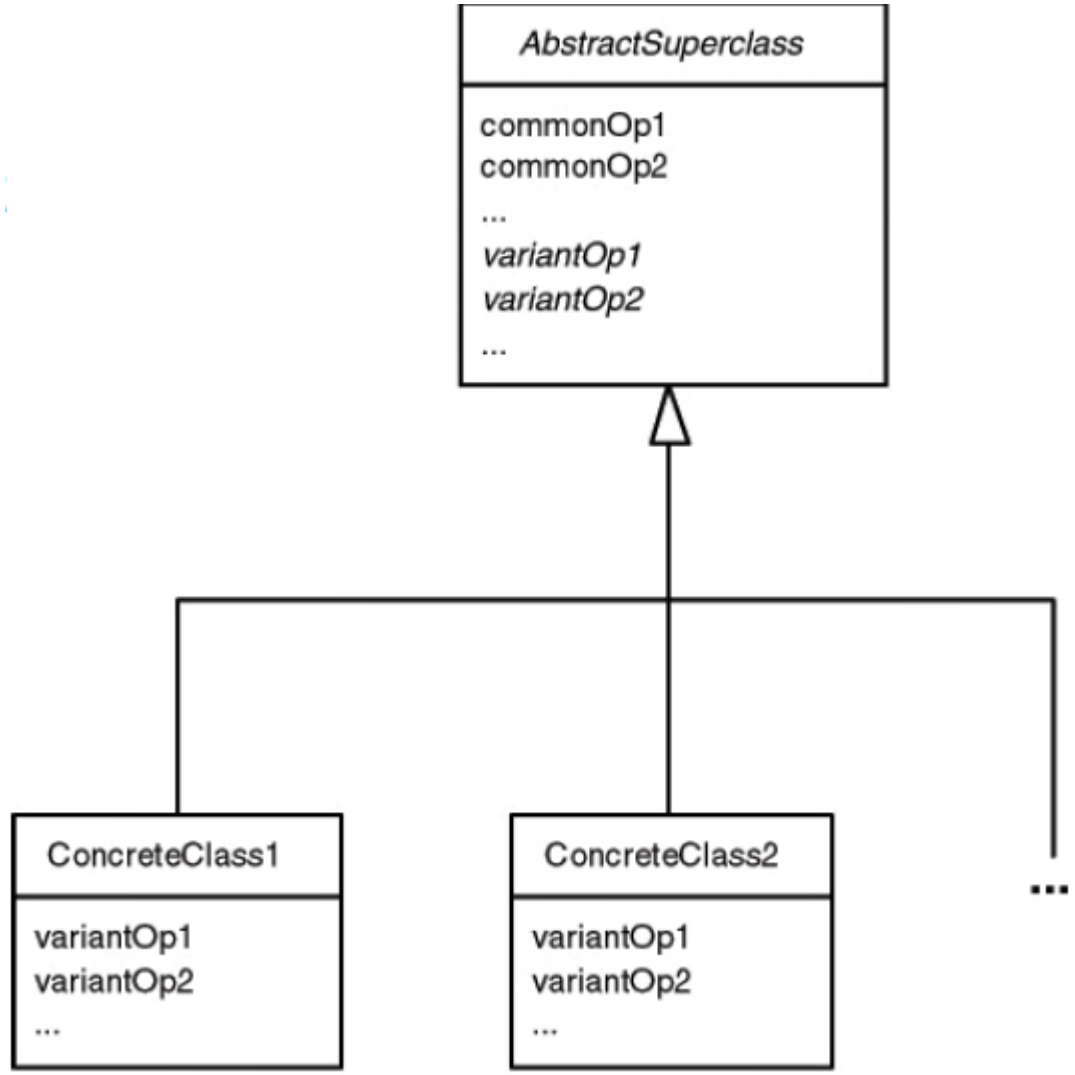
Consequences

- Programming to abstraction
- Easy change the service provider
- Transparency for client



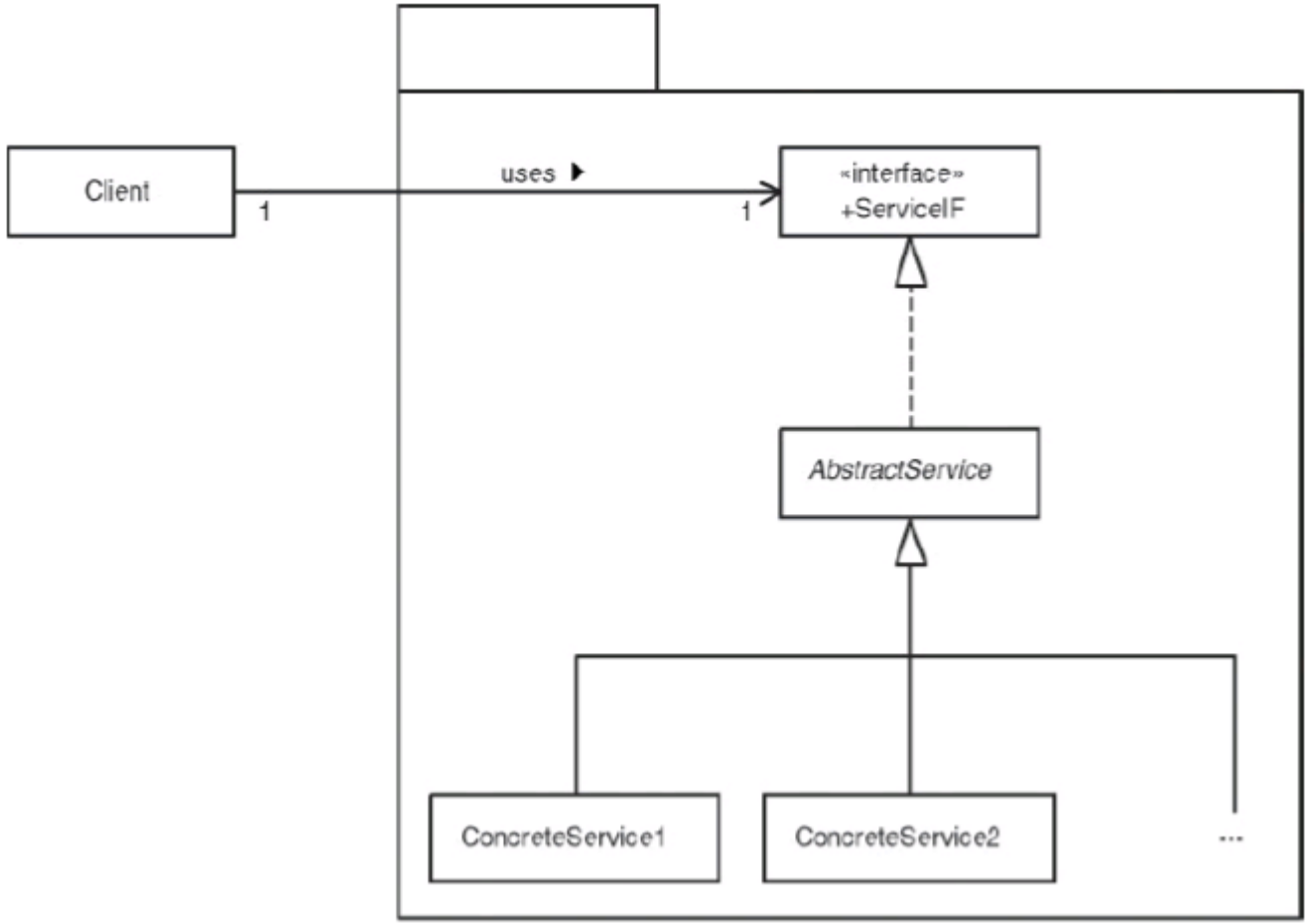
FUNDAMENTALS PATTERNS. ABSTRACT SUPERCLASS

- Abstract superclass –ensures consistent behavior for its subclasses
- Consequences:
  - Common behavior is consistent over subclasses
  - Clients are using the abstract superclass



FUNDAMENTALS PATTERNS. INTERFACE AND ABSTRACT SUPERCLASS

- Combines Interface and Abstract Superclass patterns
- Consequences:
  - Combines the advantages of both patterns
  - May provide a default behavior for the entire, or just a subset, of the ServiceIF via AbstractService

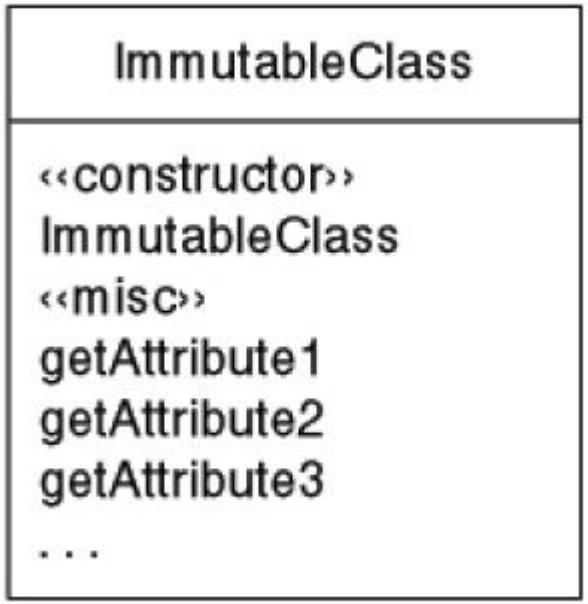


FUNDAMENTALS PATTERNS. IMMUTABLE OBJECT

- Immutable object – the internal state of the object doesn't change after its creation

- Consequences:
  - Only constructors can change object's state
  - All member functions are const functions (in C++)
  - Any member function that need to change the state will create a new instance
  - Increase design's robustness and maintainability

- Example:
  - String class in JDK



FUNDAMENTALS PATTERNS. IMMUTABLE OBJECT

```
class Position {
    private int x;
    private int y;
public Position(int x, int y) {
        this.x = x;
        this.y = y;
    } // Position(int, int)
public int getX() { return x; }
public int getY() { return y; }
public Position offset(int xOffset, int yOffset) {
        return new Position(x+xOffset, y+yOffset);
    } // offset(int, int)
} // class Position
```

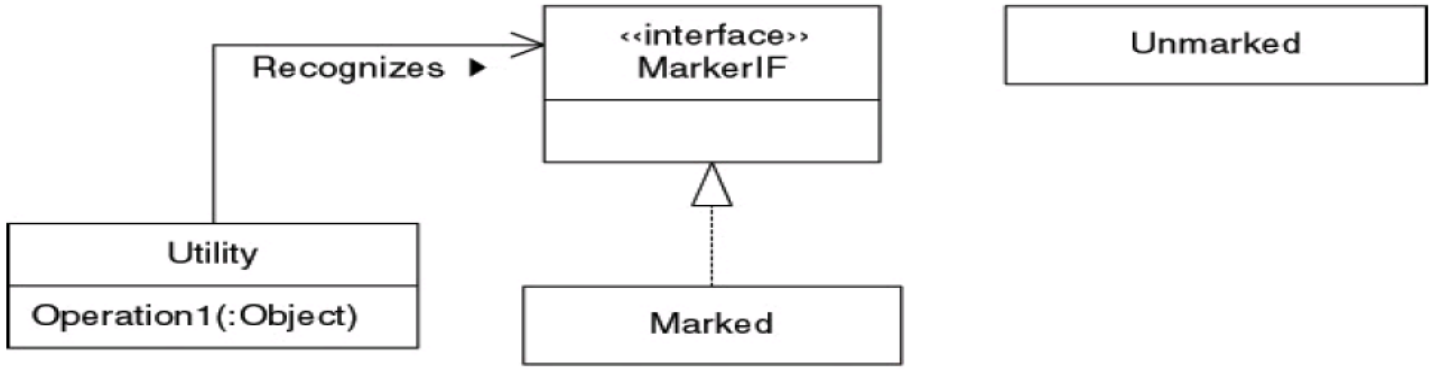
FUNDAMENTALS PATTERNS. MARKER INTERFACE

- A class implements a marker interface in order to support a semantic attribute of the system

- Motivation
  - unrelated concepts do have something in common
  - however, how to use this information is context-dependent

- Consequences:
  - Used by utility classes that need a specific behavior from their elements, without requesting a common base class

- Example:
  - Cloneable, Serializable in JDK

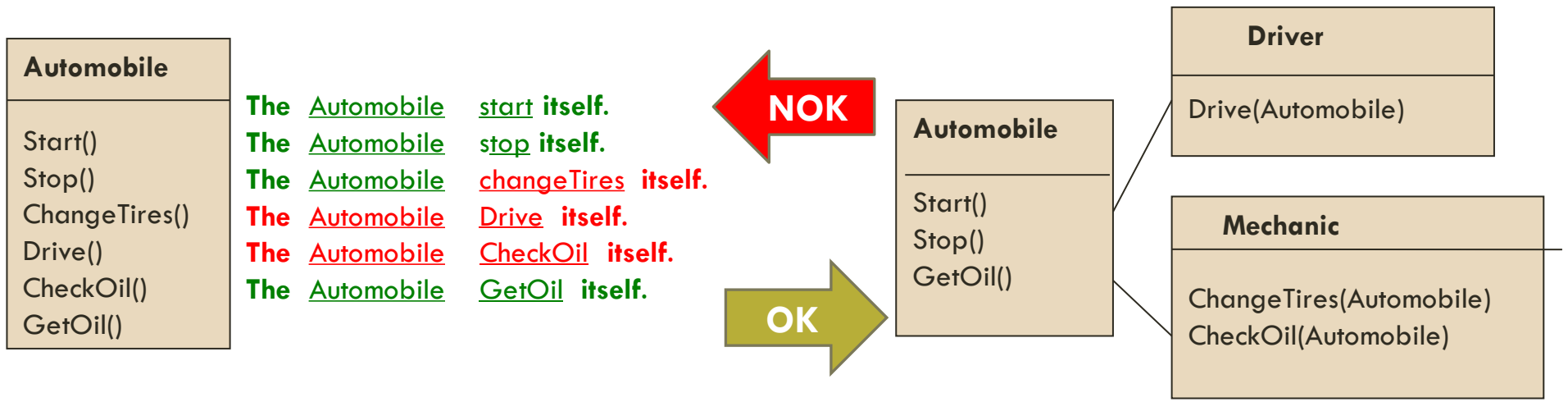


OBJECT ORIENTED DESIGN PRINCIPLES

- OOD key principles
  - collection of best practice, object-oriented design principles which can be applied to design, allowing you to accomplish various desirable goals such as loose-coupling, higher maintainability, intuitive location of interesting code, e.t.c.
- Types
  - SRP – Single Responsibility Principle
  - OCP - Open Close Principle
  - LSP – Liskov Substitution Principle
  - ISP – Interface Segmentation Principle
  - DIP – Dependency Inversion Principle
  - DRY – Don't Repeat Yourself

SINGLE RESPONSABILITY PRINCIPLE

- SRP: Every object in your system should have a single responsibility, and all the object's services should be focused in carrying out that single responsibility.
- ONLY one reason to change something!
- Code will be simpler and easier to maintain.
- Example: Container and Iterator (Container manages objects; Iterator traverses the container)
- How to spot multiple responsibilities? Forming sentences ending in itself.



OPEN CLOSE PRINCIPLE

- OCP – Classes should be open for extension and closed for modification
- Allowing change, but without modifying existing code. It offers flexibility.
- Use inheritance to extend/change existing working code and don't touch working code.
- OCP can also be achieved using composition.

```
class Shape {
        int type;
        void  drawPolygon () { /* ... */ }
        void drawPoint () { /* ... */ }
    public:
        void draw();
};
void Shape::draw() {
        switch(type) {
            case POLYGON:
                drawPolygon (); break;
            case POINT:
                drawPoint ();  break;
        }
}
```

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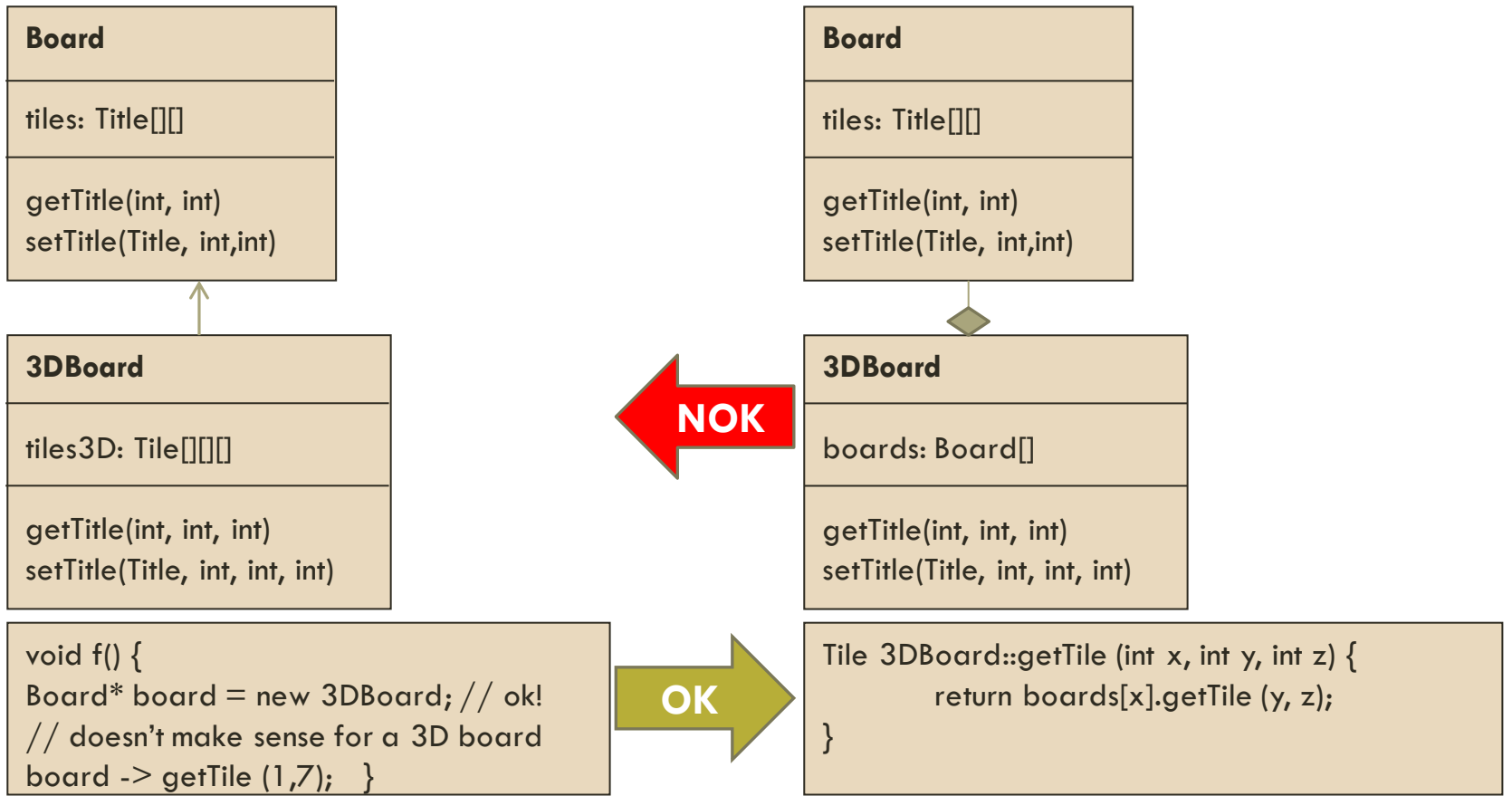
OK

```
class Shape {
    public:
        virtual void draw() = 0;
};

class Polygon : public Shape {
    public:
        void draw();
};

class Point : public Shape {
    public:
        void draw();
};

void Polygon::draw() { /* ...*/ }
void Point::draw() { /* ... */ }
```

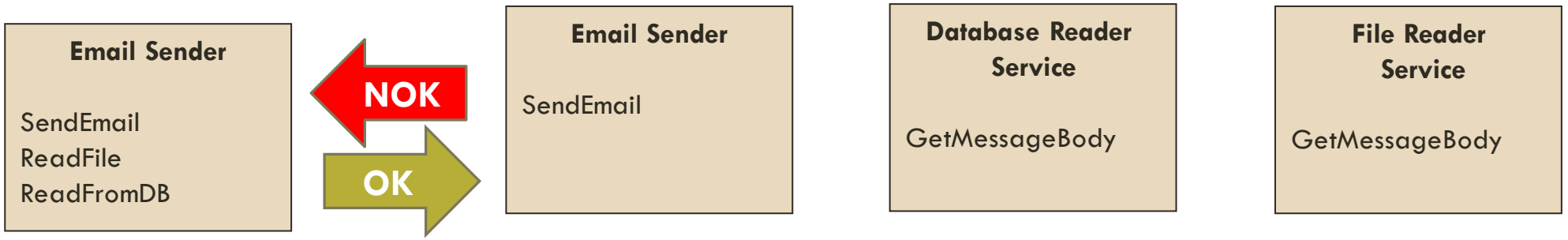
LISKOV SUBSTITUTION PRINCIPLE

- LSP: Subtypes must be substitutable for their base types.
- Well-designed class hierarchies
- Subtypes must be substitutable for their base class without things going wrong.



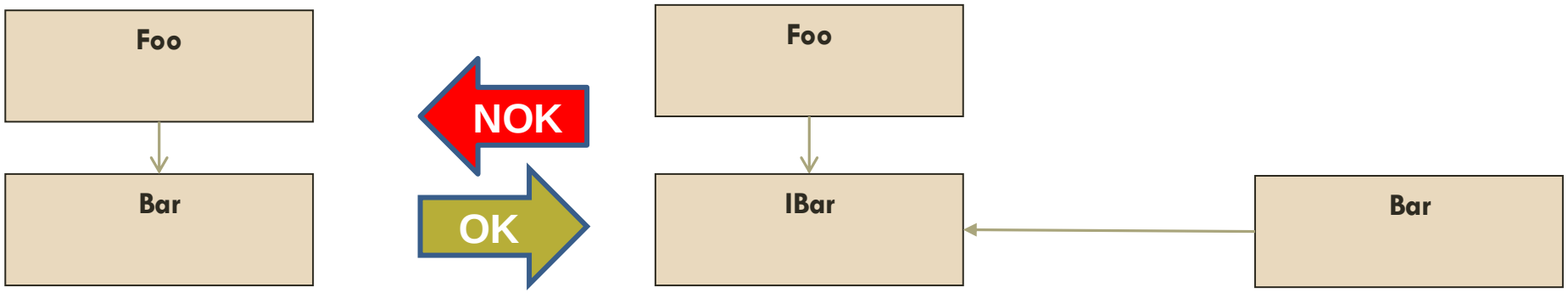
INTERFACE SEGMENTATION PRINCIPLE

- ISP: Clients should not be forced to depend on methods they do not use
- Keep interfaces small, cohesive, and focused
- Whenever possible, let the client define the interface



DEPENDENCY INVERSION PRINCIPLE

- High-level modules should not depend on low-level modules. Both should depend on abstractions
- Abstractions should not depend on details. Details should depend upon abstractions
- Detail should be dependent on Policy. This means that you should have the Policy define and own the abstraction that the detail implements.



DON'T REPEAT YOURSELF

- DRY: Avoid duplicate code by abstracting out things that are common and placing those things in a single location.
- No duplicate code => ONE requirement in ONE place!
- This principle can and should be applied everywhere (e.g. in Analysis phase –don't duplicate requirements or features!)
- Code is easier and safer to maintain because we have to change only one place.

```
String::String(const  char* pch) {
    if(pch!=NULL)  {
        str  = new char[(sz=strlen(pch))+1];
        strcpy(str,  pch);
    }  else {
        str  = NULL;
        sz   = 0;
  } }
void String::set(const  char* pch) {
    if(str!=NULL)  delete [] str;
    if(pch!=NULL)  {
        str  = new char[(sz=strlen(pch))+1];
        strcpy(str,  pch);
    } else {
        str  = NULL;
        sz   = 0;
  } }
```

NOK

OK

```
/*private*/ void String::init(const  char* pch) {
    if(pch!=NULL)  {
        str  = new char[(sz=strlen(pch))+1];
        strcpy(str,  pch);
    }
    else {
        str  = NULL;
        sz   = 0;
  }
}
String::String(const  char* pch) {
    init(pch);
}
void String::set(const  char* pch) {
    if(str!=NULL)  delete [] str;
    init(pch)
}
```