IMPLEMENTATION

Chapter 8

Software Engineering

Computer Science School

DSIC – UPV

Goals

- Discuss aspects related with the implementation of OO applications
- Discuss the foundations of software testing
- Describe tools for testing automation

Contents

- Polymorphism in programming languages
- Dynamic and Static Binding
- Software Reuse

References

- Sommerville, I. Ingeniería del Software. (8ª ed.). Addison-Wesley, 2008
- Presman, R.S., Ingeniería del Software: un enfoque práctico (6ª ed.), McGraw-Hill, 2005

- Cardelli, Luca and Wegner, peter. On Understanding Types, Data Abstraction, and PolymorphismComputing Surveys, Vol 17 n. 4, pp 471-522, December 1985 (http://lucacardelli.name/Papers/OnUnderstanding.A4.pdf)

Polymorphism in programming languages

Polymorphism

- A characteristic of an entity that lets it adopt different forms:
  - Polymorphic Variable: it may contain values of different types
  - Polymorphic Function: a function acting on polymorphic variables and it may return a polymorphic result

Polymorphism in Programming Languages

Ad-Hoc	Universal
Overloading	**Inclusive/Inheritance driven**
Cohercion	Parametric (Genericity)

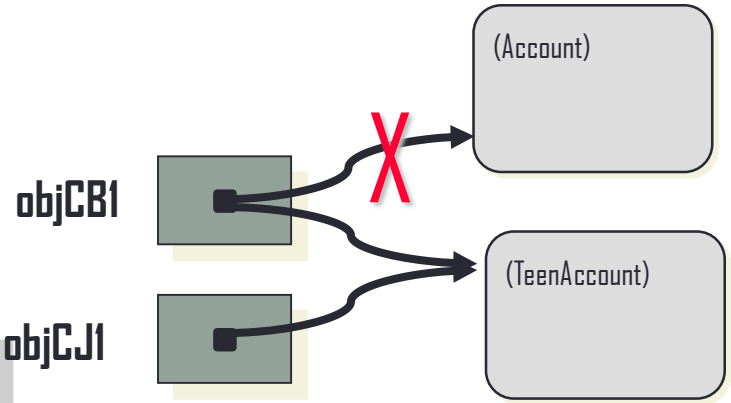
Inheritance Driven Polymorphism

Variables of a given type may refer
To instances of descendant classes

```
class Account
{
  ...
}
class TeenAccount : Account
{
  ...
}
```

```
. . .
Account objCB1 = new Account();
TeenAccount objCJ1 = new TeenAccount();

objCB1=objCJ1 ;
. . .
```



Inheritance Driven Polymorphism

```
class Account
  ...
public void f() {…}
...
}
class TeenAccount: Account
{
  ...
public void g() {…}
}
```

Objects of descendant classes are seen as objects of the parent class

```
. . .
Account objCB1 = new Account();
TeenAccount objCJ1 = new TeenAccount();

objCB1=objCJ1;
objCB1.f(); ☺
objCB1.g(); ☹  //compilation error
. . .
```

Inheritance Driven Polymorphism

- Advantages:
  - More expressive power (meaningful “is-a” relationship)
  - Heterogeneous collections can be created
- OO languages implement inheritance driven polymorphism
- However… somethingelse is needed

Dynamic and Static Binding

Definitions

- **Identifier or variable:** name used by a coder to denote entities that must be manipulated
- **Value:** real content of the computer's memory associated to a variable

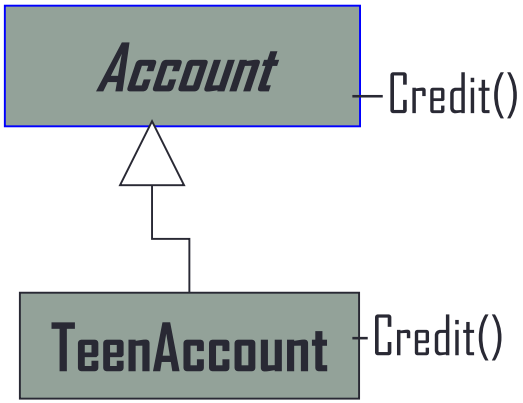
Static and Dynamic Type

In typed languages:

- **Static type assignment**: types are associated with variables or identifiers by means of explicit declarations
  - In languages with static type assignment the name (variable) of an object has both a **static** and a **dynamic type**.
    - The static type is determined at compilation time by inspecting the declaration of the variable.
    - The dynamic type may change at run time. It is determined by the type of the value referenced by the variable at a given time.
- **Dynamic type assignment:** types are bound to values

Dynamic/Static Binding

Binding: association between a message passing expression and the associated code execution at the receiver




```
Account objCB1;
TeenAccount objCJ1;
objCB1 = new Account();
objCJ1 = new TeenAccount();
objCB1 =objCJ1;
objCB1.Credit();
...
```

What method is executed in response to **objCB1.Credit()**?

We need to know the type of binding for this method

Dynamic/Static Binding

- The result will be different depending on the binding:
  - ***Static Binding***: The executed method is determined based on the static type of the variable objCB1
    - Credit() from Account would be executed
  - ***Dynamic Binding***: The executed method is determined based on the dynamic type of variable objCB1
    - Credit() from TeenAccount would be executed

Binding in main OO languages

- Java, SmallTalk, Eiffel, PHP, Perl: every non-static method has dynamic binding

- C++, C#, Object Pascal..: binding user-defined
  - By default: static
  - Dynamic binding: “virtual/override”

Example of Dynamic Binding in C#

```
class Token
{    ...
     public int LineNumber( )
     { ...
     }
     public virtual string Name( )  { ... }
}

class CommentToken: Token
{    ...
     public override string Name( ) { ... }

}
```

Dynamic Binding in C#

```
class Point
{   protected int x;
     protected int y;
   public Point (int a, int b)
     {
       x=a;  y=b;
     }
     public virtual void hide(){ . . . }
     public virtual void show() { . . . }
     public void move(int dx, int dy)
    {
      this.hide();
      x +=dx;
      y +=dy;
      this.show();
    }
}
 class Circle : Point
{
   int radius;
   public Circle(int a,int b,int c):base (a,b){ .. .}
   public override void hide() { . . .}
   public override void show() { . . . }
}
```

a) Given the following code fragment:

```
Point p;
Circle c= new Circle(10,10,15);
p=c;
p.move(5,5);
```

Q1: What hide and show methods are executed in p.move (Point or Circle)? Explain why.

Now the following method is added in the Circle class :

```
new public void move(int dx, int dy){
        this.hide();
        x=dx; y=dy;
        this.show();
    }
```

Q2: What move method is executed(Point or Circle)? Explain why.

Code Reuse

Code Reuse

- Sometimes several relevant code segments appear in many classes. To reduce duplicated code two reuse strategies may be used
  - Inheritance: the new component inherits all the behavior of the existing one and it adds new behavior ("the new one *is-an* old one")
  - Composition: the new component is based in another existing one but the former is really a different entity ("the new one *has -an* old one")

Code Reuse: Example

Let us assume we have the following class to implement collections on integer numbers…

```
class List_integers
{
   public void insert(int i){…}
   public boolean included(int i) {…}
   public boolean remove(int i){…}
   public int first_element{…}
  . . .
//Implementation
}
```

… and we want to implement a set of integers by reusing as much as possible of the List class

Code Reuse (Option 1): Inheritance

- The set is defined as a subclass of the list
- The insert method is redefined:

```
class Set_integers : List_integers
{
//redefinition to remove repeated elements:
    public void insert(int i)

    {
    …
    }
}
```

Code Reuse (Option 2): Composition

- The set is constructed over a list
- The methods of the set are implemented in terms of those of the list (delegation)

```
class Set_integers
{
 private List_integers data;

 public void insert(int i){ if (!data.included(i))
                                    data.insert(i); }
 public boolean included(int i){return data.included(i);}
 public boolean remove(int i){return data.remove(i);}

// first_element() method is hidden
   . . .
}
```