Object Thinking

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Outline

Reference: David West, “Object Thinking”, Chapters 1-5, 9

Real life example

Michael Hilzkit tells this story about the Apple's famous visit to the Xerox PARC:

Given this rare psychic encouragement, The Learning Research Group warmed to their subject. They even indulged in some of their favorite legerdemain. At one point Jobs, watching some text scroll up the screen line by line in the its normal fashion, remarked, "It would be nice if it moved smoothly, pixel by pixel, like paper".

With Ingalls at the keyboard, that was like asking a New Orleans jazz band to play "Limehouse Blues". He clicked the mouse on the window displaying several lines of SmallTalk code, made minor edit, and returned to the text, Presto! The scrolling was now continuous.

The Apple's engineer's eyes bulged in astonishment

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- Object Orientation is a *natural* way to express concepts
- Easy construction of a domain *abstraction*

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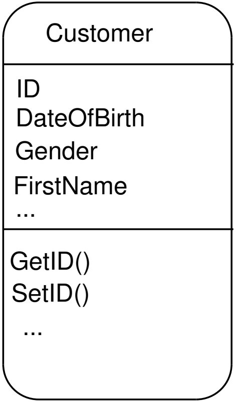
- Object Orientation is a *natural* way to express concepts
- Easy construction of a domain *abstraction*
- Object Oriented languages *increment* productivity
- It is important to learn to think like objects

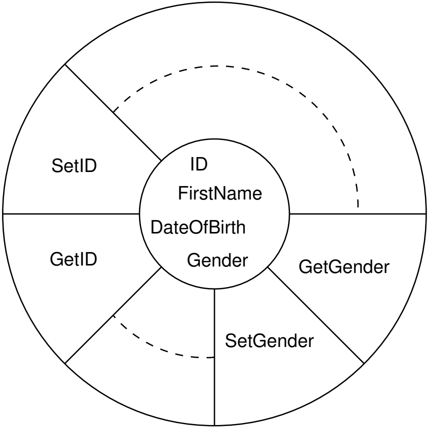
Caveat

- Object Oriented programming is not only programming with objects
- We can write non-OO programs with Java, C++, C#
- In Object Oriented programming we must think the domain as:
  - A group of objects
  - Relations between objects
  - Objects using other objects

Destroy the cathedral...

Cathedral = Old way to think objects



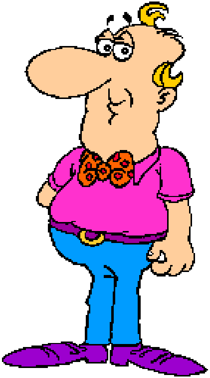


...let's build a bazaar!

Bazaar = New way to think objects

Customer

ID self
Present self
Indicate desires
Make decisions



Object thinking = Think like an object

- Traditional programmers think like *computers*
- OO programmers must learn to think like objects
- Thinking like an object is:
  - The object space is a community of *virtual persons*
  - We must concentrate on the *problem spaced* rather than the *solution space*

Virtual persons

- Objects know *their* resources
- Objects *ask* to other objects when something is needed
  - Objects do not know the internals of other objects
  - Objects *collaborate*, they do not use each other

Problem = Solution

- We must decompose a *problem* into a set of *objects*
- The *solution* is in the *interaction* of objects
- If the objects act as in the problem space *this* is the solution

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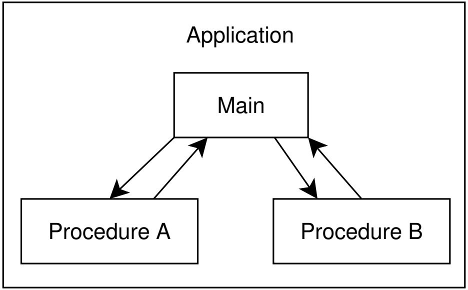
- If the objects act as in the problem space *this* is the solution
- The objects *simulate* the problem to solve it

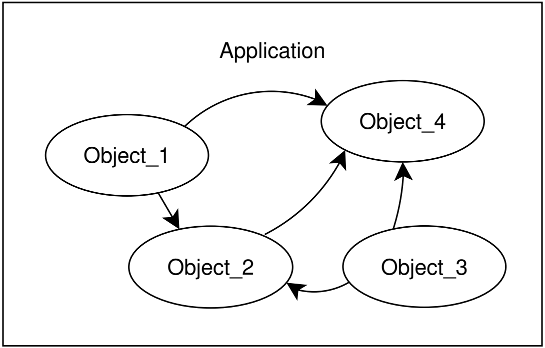
Four golden rules

- Everything is an *object*
- *Simulation* of the problem domain drives to object discovery and definition
- Objects must be *composition* enabled
- *Distributed* cooperation and communication must replace hierarchical centralized control as an organization paradigm

Traditional application (Example)



Object Oriented application (Example)



Is it simple?

Is it simple?

- NO!

Is it simple?

- NO!
- The process of being an *object thinker* is not easy
- You must start to *think like an object* and continue to learn day by day
- The *code*, and the *style*, will be better with time

Terms to deal with

- First of all we must define the basic *terms*

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  - Class
  - Object
  - Responsibility
  - Message and method

Class

- *Classes* are the fundamental units of understanding
- We define the world in terms of *objects* associated to some *class*
- *Classes* define attributes and methods of the *objects* of its kind

Class (Example)


```
class Integer{
   int val;

   void SetValue(int x){ val := x; }
   int GetValue(){ return val; }
   Integer +(Integer o){
      Integer i := new Integer();
      i.SetValue(o.GetValue()+val);
      return i;
   }
}
```

Object

- An *object* is an instance of a class.
- An *object* can be uniquely identified by its name
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Object (Example)

```
class Integer{
   int val;

   void SetValue(int x){ ... }
   int GetValue(){ ... }
   Integer +(Integer o){ ... }
}

Integer i := new Integer(); //Object
Integer j := new Integer(); //Object

i.SetValue(2);
j.SetValue(3);

Integer k := i + j; // i.+(j)
```

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  - An object is everything capable to provide a limited set of services
  - The only way to create an application is to compose objects
- The responsibility of an object is known also as the *interface* that the object implements

Responsibility (Example)


```
class Integer{
   void SetValue(int x){ ... }
   int GetValue(){ ... }
   Integer +(Integer o){ ... }
}
```

- An *Integer* object does only what it is intended to do:
  - We can set or get its value
  - We can perform some math operations on it

Messages and methods

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  - The name of the method and
  - The arguments of the method.
- A *method* is associated with a class. An object invokes one of its class methods as a reaction to the message

Messages and method (Example)

```
class Integer{
   int val;

   void SetValue(int x){ val := x; }
   ...
}

Integer i := new Integer();
i.SetValue(42);
```

- The last instruction must be interpreted as:
  - We send a message to *i*, the message says: “please set your value to 42”
  - When the object *i* receives the message it performs the operation(s) in the body of method `SetValue` to change its *status*

Object Oriented programming: how to do it

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  - Polymorphism

Object Oriented programming: how to do it

- After terms we need *techniques*
  - Relation between classes
  - Polymorphism
- Followings are general techniques, you must adapt them to tools that you use

Relations between classes

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  - *is-part-of* and *has-a*
  - *uses-a* and *is-used-by*

Is-a-kind-of and is-a

- We say that *Foo* class is-a-kind-of *Bar* class if *Foo* has the same responsibilities of *Bar*
- We say that an object *f* of *Foo* is-a *b* of class *Bar* if *Foo* *is-a-kind-of Bar*

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- *is-a-kind-of* is a relation between classes
- *is-a* is a relation between objects
- Inheritance is the way in which a *is-a-kind-of* relation (and *is-a* relation too) is established.

Is-a-kind-of (Example)

```
class Integer{
   void SetValue(int x){ ... }
}

class UnsignedInteger: Integer{
   void SetValue(int x){
      if(x >= 0){
         Integer::SetValue(x);
      }else{
         RaiseException();
      }
   }
   ...
}
```

Is-a (Example)


```
VectorOfInteger v := new VectorOfInteger();

Integer i := new Integer();
i.SetValue(-3);
v.Add(i);

UnsignedInteger u := new UnsignedInteger();
u.SetValue(42);
v.Add(u); //an UnsignedInteger is-a Integer
```

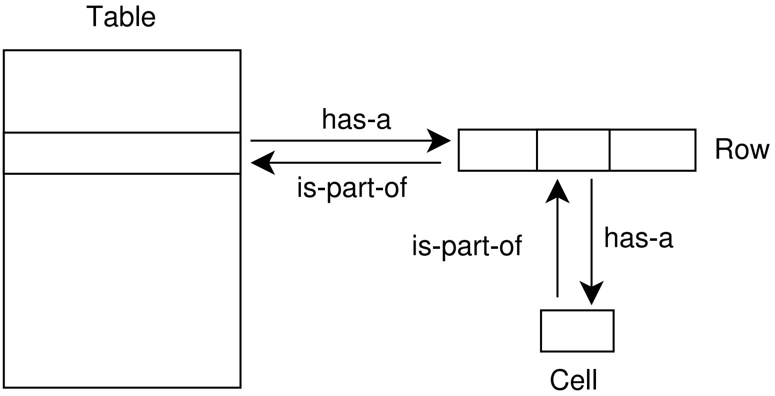
Is-part-of and has-a

- We say that *Foo* class is-part-of *Bar* class if *Bar* has one, or more, attributes of type *Foo*
- Has-a is exactly the opposite of *is-part-of* relation

Is-part-of and has-a

- We say that *Foo* class is-part-of *Bar* class if *Bar* has one, or more, attributes of type *Foo*
- Has-a is exactly the opposite of *is-part-of* relation
- Composition is the way in which a *is-part-of* relation (and *has-a* relation too) is established.

Is-part-of and has-a (Example)



Uses-a and is-used-by

- We say that *Foo* class use-a *Bar* class if *Foo* knows how to use an object of type *Bar* but with out *Bar is-part-of Foo*
- Is-used-by is exactly the opposite of *uses-a* relation

Uses-a (Example)


```
class Output{
    ...
    void Print(Integer i){...}
    ...
}

Output o = new Output();
Integer i = new Integer();
i.SetValue(42);
o.Print(i);
```

The *Output* class knows how to manage an *Integer* object but after the `Print` method execution there is no more trace of object *i* in object *o*

Polymorphism

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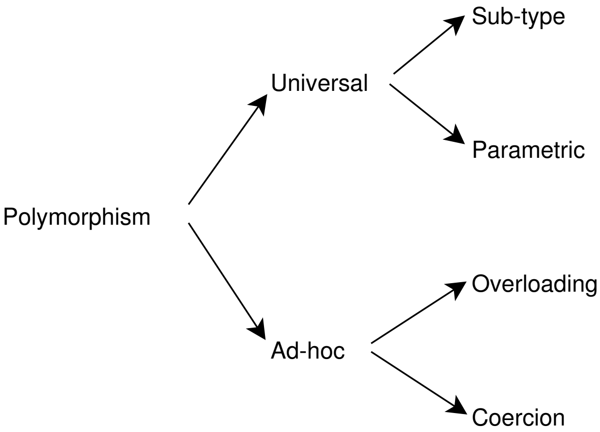
- When we send a message to an object, the object can *interpret* the message in *various ways*
- As a consequence of this multiple classes can expose the same *interface*
- The same message can yield many, different, responses
- The sender interest moves from how a class performs some task to what a class can perform

Polymorphism classification



Sub-type polymorphism

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- With *method overriding* we redefine in a subclass methods of the super class(es)
- With the use of *late binding* we are able to dispatch the message to the right receiver
- We can use, as base classes, *abstract* classes

Abstract classes

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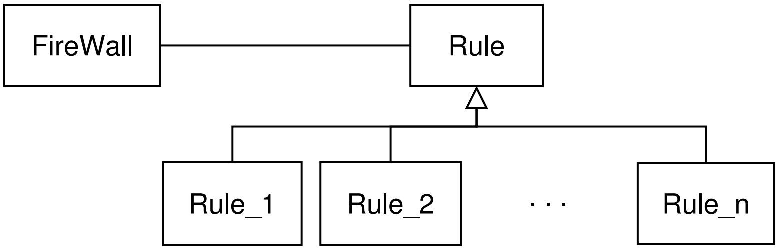
  - Other responsibilities implementation is leaved to sub classes
- In some languages (Java, C#...) classes that implement none of their responsibilities are called *interfaces*

Sub-type polymorphism (Example)



With out sub-type polymorphism (Example)

```
class Rule{
   type_t t;
   type_t GetType(){return t;}
   void SetType(type_t x){t := x;}
   abstract bool MustDiscard(Message m);
}

class Rule_1: Rule{
   Rule_1(){ Rule::SetType(RULE_1);}
   bool MustDiscard(Message m){ ... }
}

class Rule_2: Rule{
   Rule_2(){ Rule::SetType(RULE_2);}
   bool MustDiscard(Message m){ ... }
}
```

With out sub-type polymorphism (Example 2)

```
class FireWall{
   Rule rule[N];
   int rulesnumber;
   ...
   void AppendRule(Rule r){ ... }
   bool MustDiscard(Message m){
      bool res = false; int i = 0;
      while(i < rulesnumber){
         if(rule[i].GetType() = RULE_1){
              res = ((Rule_1)rule[i]).MustDiscard(m);
              if(res = true){break;}
         }elsif(...){...}
         ...
      }
      return res;
   }
```

With sub-type polymorphism (Example)

```
class Rule{
   abstract bool MustDiscard(Message m);
}

class Rule_1: Rule{
   bool MustDiscard(Message m){ ... }
}

class Rule_2: Rule{
   bool MustDiscard(Message m){ ... }
}
```

With out sub-type polymorphism (Example 2)

```
class FireWall{
   Rule rule[N];
   int rulesnumber;
   ...
   void AppendRule(Rule r){ ... }
   bool MustDiscard(Message m){
      bool res = false; int i = 0;
      while(i < rulesnumber){
         res = rule[i].MustDiscard(m);
         if(res = true){
            break;
         }
      }
      return res;
   }
}
```

Parametric polymorphism

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- *Generic coding* permits to write one piece of code for multiple types
- C++ templates are an example of parametric polymorphism

Parametric polymorphism (Example)


```
class Buffer of T{
   T v[N];

   void AddAt(int idx, T val){
      if(idx < N){
         v[idx] := val;
      }else{
         RaiseException();
      }
   }
}
```

Overloading polymorphism

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- With *overloading polymorphism* we are able to write multiple versions of the same method with different signature
- The compiler dispatch the message to the right method using the type information

Overloading polymorphism (Example)

```
class Output{
   void Print(int i){...}
   void Print(string s){...}
   void Print(real r){...}
}

...

Output o = new Output();
o.Print(42);
o.Print(``foo'');
o.Print(5.0);
```

Coercion polymorphism

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- With *coercion polymorphism* we are able to perform automatic type conversions
- We are able to do a kind of *overloading polymorphism* in a implicit way
- In C++ we can use operator overloading with cast operators to perform automatic cast

Coercion polymorphism (Example)

```
class Real{
   real val;

   void SetValue(real r){val := r}
}

Real r = new Real();
r.SetValue(5.0);
r.SetValue(42);//42 -> 42.0
```

The effect is similar to the one in which we define `SetValue(int)` in the *Real* class.

Conclusions

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- The only way to learn *object thinking* is to practice and to apply the concepts seen in this lecture

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- The only way to learn *object thinking* is to practice and to apply the concepts seen in this lecture
- Good work!