CS 635 Advanced Object-Oriented Design & Programming
Spring Semester, 2007
Doc 11 Object Coupling
Mar 6, 2007

References

http://c2.com/cgi/wiki?TemplateMethodPattern WikiWiki comments on the Template Method

http://wiki.cs.uiuc.edu/PatternStories/TemplateMethodPattern Stories about the Template Method

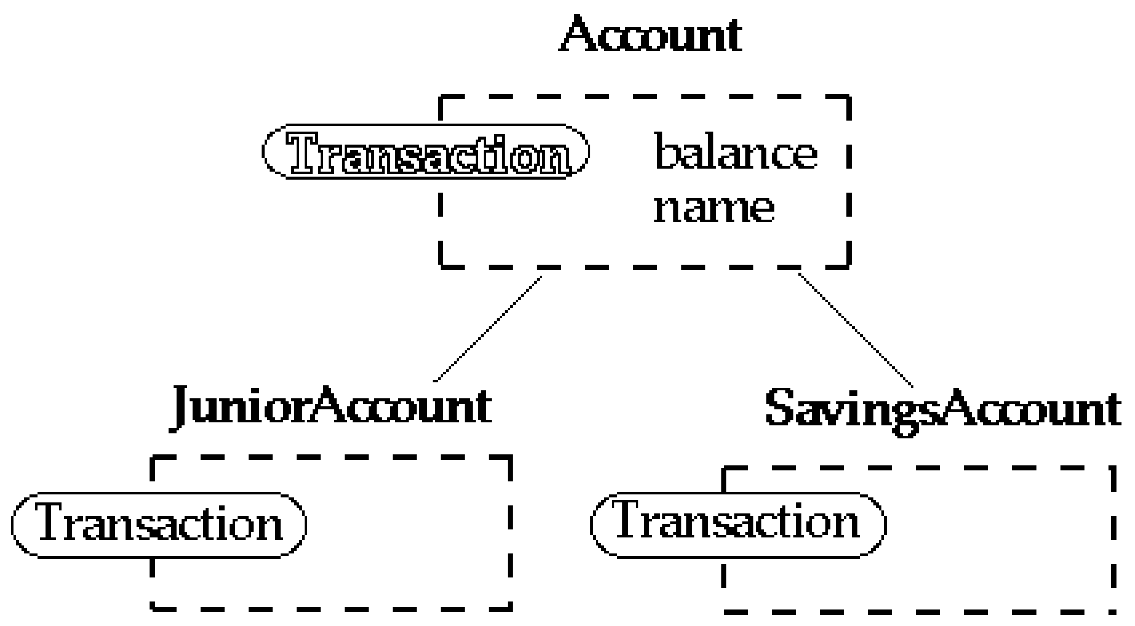
Design Patterns: Elements of Resuable Object-Oriented Software, Gamma, Helm, Johnson, Vlissides, Addison Wesley, 1995, pp. 325-330, 163-174

Polymorphism

```
class Account {
        public:
                void virtual Transaction(float amount)
                                { balance += amount;}
                Account(char* customerName, float InitialDeposit = 0);
        protected:
                char* name;
                float balance;
}

class JuniorAccount : public Account {
        public:     void Transaction(float amount) {//code here}
}

class SavingsAccount : public Account {
        public:     void Transaction(float amount) {//code here}
}

Account* createNewAccount(){
        // code to query customer and determine what type of
        // account to create
};
```

```
main() {
        Account*  customer;
        customer = createNewAccount();
        customer->Transaction(amount);
}
```

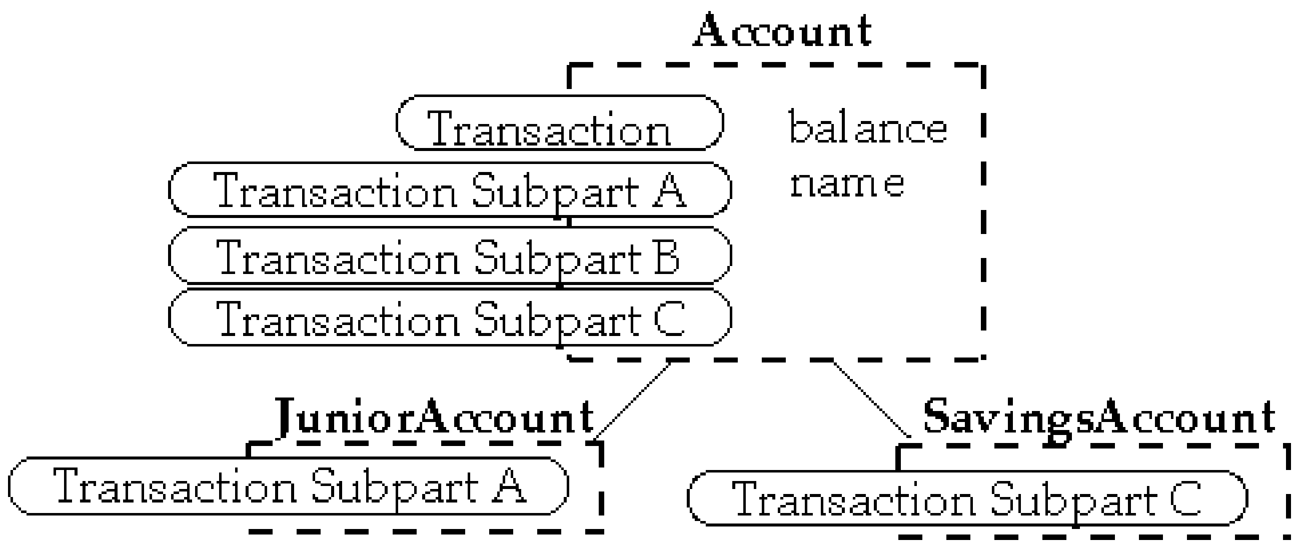
Deferred Methods



```
class Account {
	public:
		void virtual Transaction() = 0;
}

class JuniorAccount : public Account {
	public
		void Transaction() { put code here}
}
```

Template Method

```
class Account {
        public:
                void Transaction(float amount);
        protected:
                void virtual TransactionSubpartA();
                void virtual TransactionSubpartB();
                void virtual TransactionSubpartC();
}

void Account::Transaction(float amount)  {
        TransactionSubpartA();          TransactionSubpartB();
        TransactionSubpartC();          // EvenMoreCode;
}

class JuniorAccount : public Account {
        protected:      void virtual TransactionSubpartA(); }

class SavingsAccount : public Account {
        protected:      void virtual TransactionSubpartC(); }

Account*  customer;
customer = createNewAccount();
customer->Transaction(amount);
```



Intent

Define the skeleton of an algorithm in an operation, deferring some steps to subclasses

Template Method lets subclasses redefine certain steps of an algorithm without changing the algorithm’s structure

Java Example

```
    import  java.awt.*;
    class  HelloApplication  extends  Frame
        {
        public  void  paint(  Graphics  display  )
            {
            int startX  =  30;
            int startY  =  40;
            display.drawString(  "Hello World", startX,
startY  );
            }
        }
```

Ruby LinkedList Example

```
class LinkedList
  include Enumerable

  def [](index)
    Code not shown
  end

  def size
    Code not shown
  end

  def each
     Code not shown
  end

  def push(object)
   Code note shown
  end

end
```

```
def testSelect
  list = LinkedList.new
  list.push(3)
  list.push(2)
  list.push(1)

  a = list.select {|x| x.even?}
  assert(a == [2])
end
```

Where does list.select come from?

Methods defined in Enumerable

all?	any?	collect	detect
each_cons	each_slice	each_with_index	entries
enum_cons	enum_slice	enum_with_index	find
find_all	grep	include?	inject
map	max	member?	min
partition	reject	select	sort
sort_by	to_a	to_set	zip

All use "each"

Implement "each" and the above will work

java.util.AbstractCollection

Subclass AbstractCollection

Implement

- iterator
- size
- add

Get

- addAll
- clear
- contains
- containsAll
- isEmpty
- remove
- removeAll
- retainAll
- size
- toArray
- toString

Consequences

This is the most commonly used of the 23 GoF patterns

Important in class libraries

Inverted control structure

- Parent class calls subclass methods
- Java's paint method is a primitive operation called by a parent method
- Beginning Java programs don't understand how the following works:

```
import  java.awt.*;
class  HelloApplication  extends  Frame
    {
    public  void  paint(  Graphics  display  )
        {
        int startX  =  30;
        int startY  =  40;
        display.drawString(  "Hello World", startX, startY  );
        }
    }
```

Consequences

Template methods tend to call:

- Concrete operations
- Primitive (abstract) operations
- Factory methods
- Hook operations
  - Provide default behavior that subclasses can extend

It is important to denote which methods

- Must overridden
- Can be overridden
- Can not be overridden

Code Refactoring

Any change to a computer program which improves its

readability or
simplifies its structure

without changing its results

Source Wikipedia

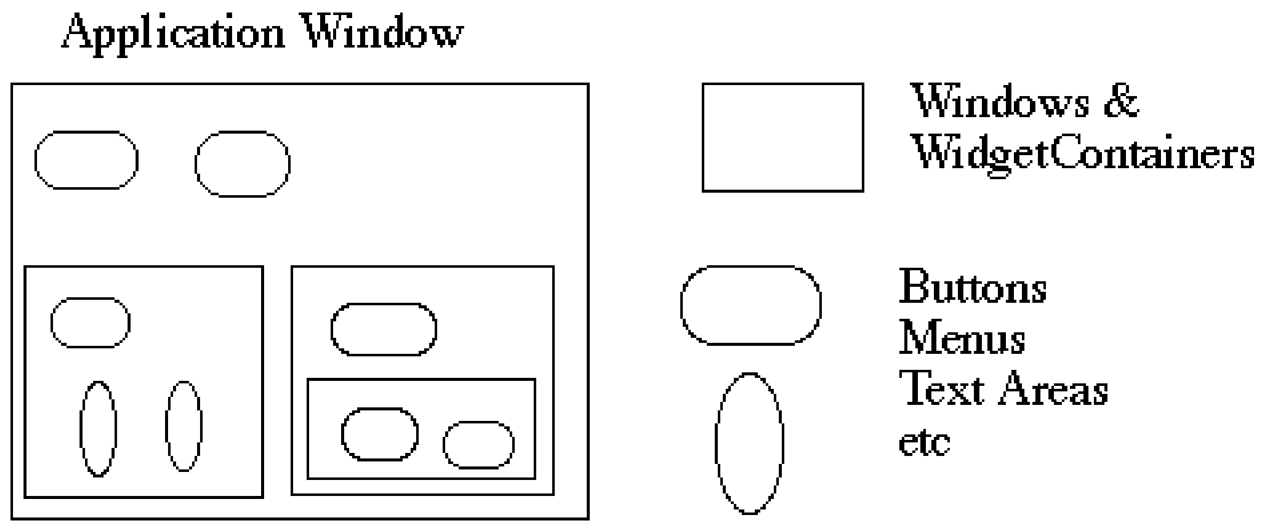
Refactoring to Template Method

- Simple implementation
    - Implement all of the code in one method
    - The large method you get will become the template method
- Break into steps
    - Use comments to break the method into logical steps
    - One comment per step
- Make step methods
    - Implement separate methods for each of the steps
- Call the step methods
    - Rewrite the template method to call the step methods
- Repeat above steps
    - Repeat the above steps on each of the step methods
    - Continue until:
        - All steps in each method are at the same level of generality
        - All constants are factored into their own methods

Design Patterns Smalltalk Companion pp. 363-364.

Composite

Motivation



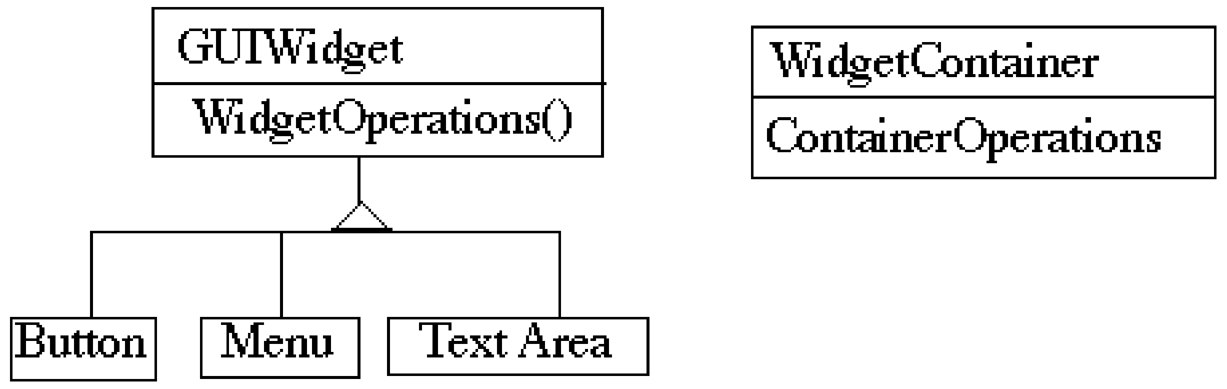
How does the window hold and deal with the different items it has to manage?

Widgets are different that WidgetContainers

Bad News

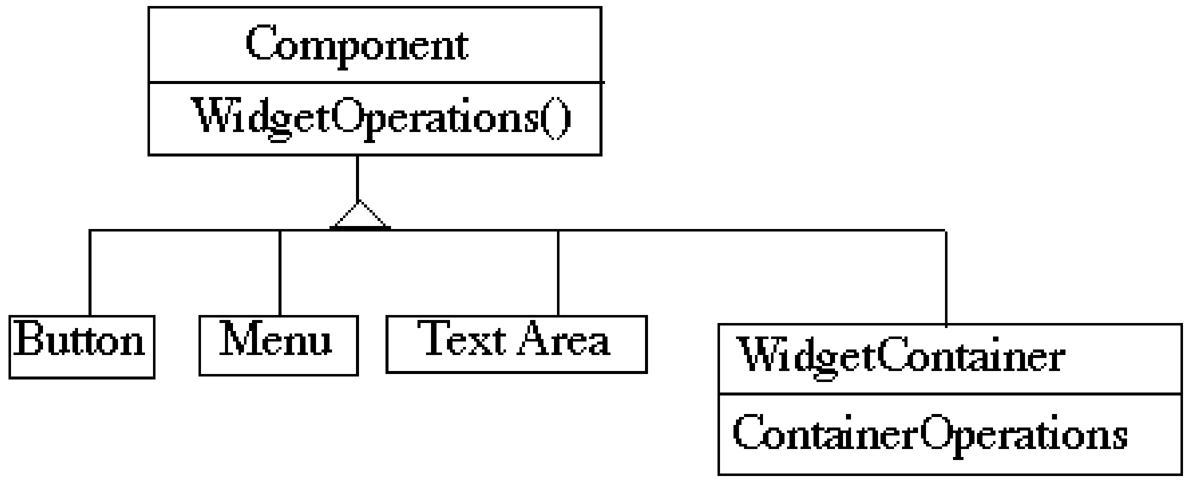
```
class Window {
    Buttons[] myButtons;
    Menus[] myMenus;
    TextAreas[] myTextAreas;
    WidgetContainer[] myContainers;

    public void update() {
        if ( myButtons != null )
            for ( int k = 0; k < myButtons.length(); k++ )
                myButtons[k].refresh();
        if ( myMenus != null )
            for ( int k = 0; k < myMenus.length(); k++ )
                myMenus[k].display();
        if ( myTextAreas != null )
            for ( int k = 0; k < myButtons.length(); k++ )
                myTextAreas[k].refresh();
        if ( myContainers != null )
            for ( int k = 0; k < myContainers.length(); k++ )
                myContainers[k].updateElements();
        etc.
    }
    public void fooOperation(){
        if (myButtons != null)
        etc.
```

An Improvement



```
class Window {
    GUIWidgets[] myWidgets;
    WidgetContainer[] myContainers;

    public void update(){
        if ( myWidgets != null )
            for ( int k = 0; k < myWidgets.length(); k++ )
                myWidgets[k].update();
        if ( myContainers != null )
            for ( int k = 0; k < myContainers.length(); k++ )
                myContainers[k].updateElements();
        etc.
    }
}
```

Composite Pattern



Component implements default behavior for widgets when possible

Button, Menu, etc overrides Component methods when needed

WidgetContainer will have to overrides all widgetOperations

```
class WidgetContainer {
        Component[] myComponents;

        public void update() {
                if ( myComponents != null )
                        for ( int k = 0; k < myComponents.length(); k++ )
                                myComponents[k].update();
        }
}
```

Issue - WidgetContainer Opeartions

Should the WidgetContainer operations be declared in Component?

Pro - Transparency

Declaring them in the Component gives all subclasses the same interface

All subclasses can be treated alike. (?)

Con - Safety

Declaring them in WidgetContainer is safer

Adding or removing widgets to non-WidgetContainers is an error

One out is to check the type of the object before using a WidgetContainer operation

Issue - Parent References

```
class WidgetContainer
	{
	Component[] myComponents;

	public void update() {
		if ( myComponents != null )
			for ( int k = 0; k < myComponents.length(); k++ )
				myComponents[k].update();
	}

	public add( Component aComponent ) {
		myComponents.append( aComponent );
		aComponent.setParent( this );
	}
}

class Button extends Component {
	private Component parent;
	public void setParent( Component myParent) {
		parent = myParent;
	}

	etc.
```

More Issues

Should Component implement a list of Components?

- The button etc. will have a useless data member

Child ordering is important in some cases

Who should delete components?

Applicability

Use Composite pattern when you want

To represent part-whole hierarchies of objects

Clients to be able to ignore the difference between compositions of objects and individual objects