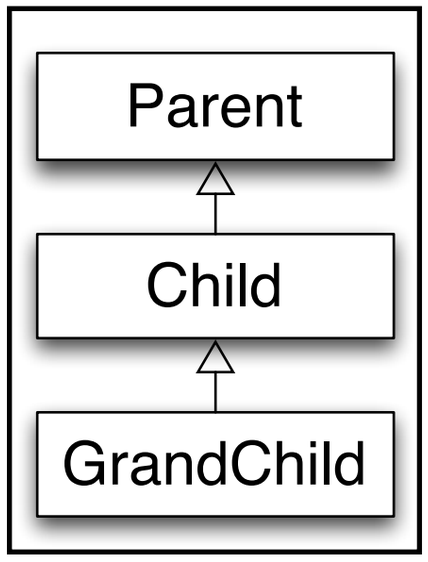
CS 535 Object-Oriented Programming & Design
Fall Semester, 2008
Doc 7 Polymorphism, Object, Testing
Sept 17 2008

References

Object-Oriented Design Heuristics, p 98

Polymorphism




```
Parent>>name
   ^'Parent'

Parent>>age
      ^50

Parent>>total
      ^self name size + self age
```

Which method is called

aPerson := ??? new.

aPerson name

aPerson age

aPerson total

```
GrandChild>>name
   ^'GrandChild'

GrandChild>>age
      ^super age - 18
```

```
Child>>name
   ^'Child'

Child>>age
   ^super age - 15
```

when ??? is

Parent

Child

GrandChild

Template Method

```
Parent>>total
    ^self name size + self age
```

Parent method (total) defines algorithm using methods

Subclasses implement those methods

Object

All 'things' in Smalltalk are objects

Objects are created from classes

The class Object is the parent class of all classes

Object class contains common methods (270) for all objects

Determines behavior for all objects

printString

Returns a string representation of the receiver
Similar to toString in Java

5 printString	'5'
$a printString	'$a "16r0061"'
#(1 2 3) printString	'#(1 2 3)'
a:= ClassPoint new. a printString	'a ClassPoint'

Implementing printString for ClassPoint

```
ClassPoint>>printOn: aStream
        aStream
                nextPut: $(;
                print: x ;
                nextPut: $,;
                space;
                print: y;
                nextPut: $).
```

a:= ClassPoint new. a x: 4; y: -1. a printString	'(4, -1)'

Where is printStream?

Object uses Template Method

```
Object>>printString
    "Answer a String whose characters are a description of the receiver."

    | aStream |
    aStream := WriteStream on: (String new: 16).
    self printOn: aStream.
    ^aStream contents
```

printString is a template method

You just implement printOn: and printString will work

Remember "do it once and only once"? Template method is one way of achieving that. Since the standard way of creating a string representation is to create a WriteStream (don't worry about what that is), write to the stream and then return the contents of the stream we put the common code in Object and just implement the part specific to our class. We could implement the entire logic in each class, but that would not be "do it once and only once".

Useful WriteStream methods

```
ClassPoint>>printOn: aStream
        aStream
                nextPut: $(;
                print: x ;
                nextPut: $,;
                space;
                print: y;
                nextPut: $).
```

```
nextPutAll: aString
nextPut: aCharacter
print: anObject
cr
space
tab
crtab
```

isInteger

'cat' isInteger	false
$5 isInteger	false
4 isInteger	true
4.5 isInteger	false

```
Object>>isInteger

    ^false
```

```
Integer>>isInteger

    ^true
```

Replace case (if) with Polymorphism

```
Object>>isInteger
    ^self class = Integer
```

verses

```
Object>>isInteger

    ^false
```

```
Integer>>isInteger

    ^true
```

Polymorphism makes change easier

What if we add a new type of Integer?

```
Object>>isInteger
    self class = Integer
        ifTrue: [^true].
    self class = CS535Integer
        ifTrue: [^true].
    ^false
```

verses

```
Object>>isInteger

    ^false
```

```
Integer>>isInteger

    ^true
```

```
CS535Integer>>isInteger

    ^true
```


When we add a new type of Integer class we just have to make sure it returns the correct result. We do not have to find and change all the if or case statements that check to see if something is an integer.

Avoid checking the type of an Object

Heuristic 5.12
Explicit case analysis on the type of an object is usually an error.
The designer should use polymorphism in most of these cases

```
Transcript show: anObject printString

        verses

anObject isInteger
    ifTrue: [Transcript show: anObject printString].
anObject isString
    ifTrue: [Transcript show: anObject].
anObject isArray
    ifTrue: [anObject do: [:element | Transcript show: element].
```

Equality

All objects are allocated on the heap
Variables are references (like a pointer) to objects

A == B

Returns true if the two variables point to the same location

A = B

Returns true if the two variables point to equivalent objects

In Smalltalk you want to use '=' nearly all the time

A ~= B

Means (A = B) not

A ~~ B

Means (A == B) not

Defining =

If you define = also define hash

```
ClassPoint>>= anObject
	anObject isPoint ifFalse:[^false].
	^self x = anObject x and: [self y = anObject y]


ClassPoint>>hash

	^x hash hashMultiply bitXor: y hash
```

Testing

Johnson's Law

If it is not tested it does not work

Types of tests

Unit Tests

Tests individual code segments

Functional Tests

Test functionality of an application

Why Unit Testing

The more time between coding and testing

- More effort is needed to write tests
- More effort is needed to find bugs
- Fewer bugs are found
- Time is wasted working with buggy code
- Development time increases
- Quality decreases

Without unit tests

- Code integration is a nightmare
- Changing code is a nightmare

Unit Tests Must be Easy To Run

Must be able to

- Easily run many tests at once
- Allow others to run the tests
- Keep the tests for later
- Scale with more developer and project size

Test stored in a workspace

- Do not work in any sizable project
- Do not work well with multiple programmers
- Are easily lost
- Are not run very often

Testing First

First write the tests

Then write the code to be tested

Writing tests first:

- Removes temptation to skip tests
- Makes you define of the interface & functionality of the code before

SUnit

Testing framework for automating running of unit tests in Smalltalk

In SUnit

- Programmer manually writes the test
- SUnit automates the running of the test
- Simplifies finding tests that fail

Ports to other languages can be found at:
http://www.xProgramming.com/software.htm

Three GUI Interfaces for viewing Test Results

TestRunner

- Already loaded in Image

Browser SUnit Extensions

- Easier to run individual tests
- Needs to be loaded

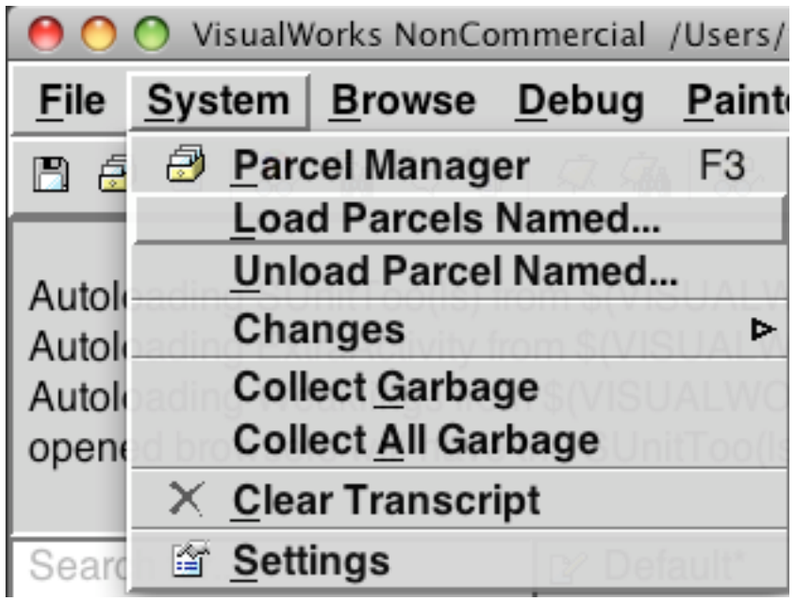
SUnitToo

- Auotmates more actions

Loading SUnitToo

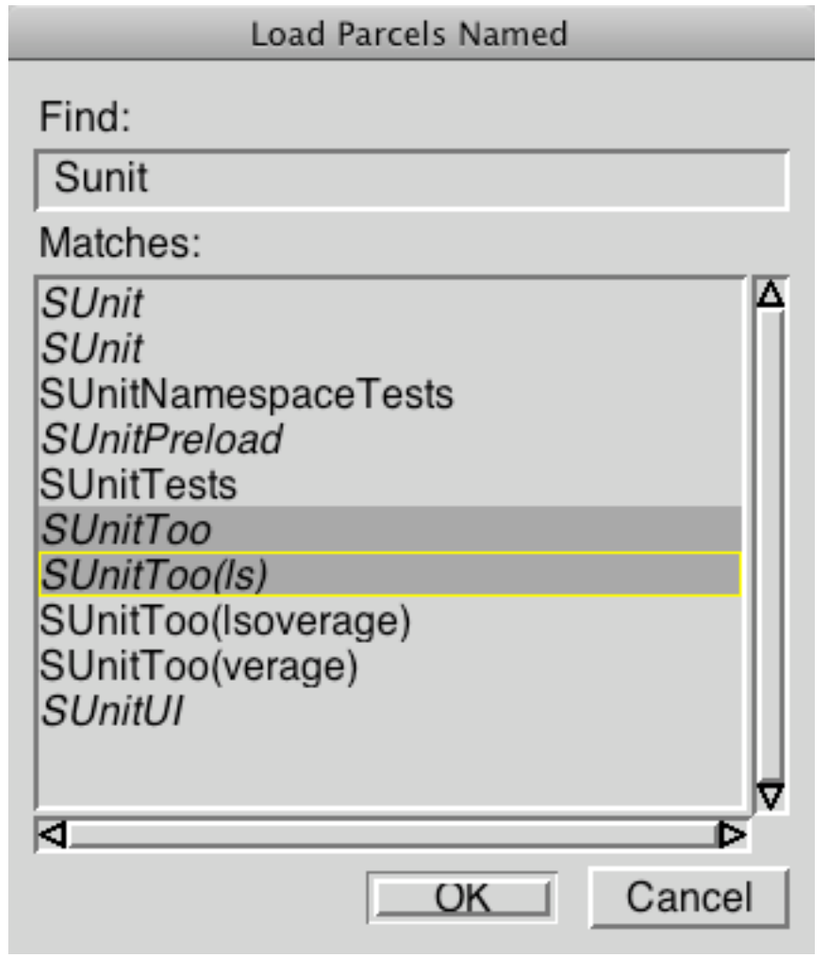
Step 1

In Launcher window



Website has a screencast
of loading and using SUnitToo

Step 2



Sample Test Case

ClassPointTest>>testX

```
| aPoint |
aPoint := ClassPoint new.
self
      assert: aPoint x = 0;
      assert: aPoint y = 0.
aPoint x: 5.
self assert: aPoint x = 5.
self deny: aPoint x = 10.
```

ClassPointTest is subclass of SUnit.TestCase

Framework runs methods whose name start with test

This is a silly test. We don't need to test an setter method. But this is just an example of a test method.

Important Methods of TestCase

assert: aBooleanExpression
deny: aBooleanExpression
should: [aBooleanExpression]
should: [aBooleanExpression] raise: AnExceptionClass
shouldnt: [aBooleanExpression]
shouldnt: [aBooleanExpression] raise: AnExceptionClass
signalFailure: aString

Another Example

```
testZeroDivide
    self
        should: [1/0]
        raise: ZeroDivide.

    self
        shouldnt: [1/2]
        raise: ZeroDivide

self should: [2 = 1 + 1]
```

setUp & tearDown

setUp

Called before running each test method

tearDown

Called after running each test method

Used to set up and tear down items for tests

files

database connections

objects needed for test methods

Example

```
ClassPointTest>>setUp

    largePoint := ClassPoint new.
    largePoint
        x: 100;
        y: 100
```

```
ClassPointTest>>testLarge
    self assert: largePoint x = 100.
    largePoint x: 10.
    self assert: largePoint x = 10.
```