CS 535 Object-Oriented Programming & Design
Fall Semester, 2008
Doc 6 Inheritance & Variables
Sept 11 2008

References

Ralph Johnson's University of Illinois, Urbana-Champaign CS 497 lecture notes, http://st-www.cs.uiuc.edu/users/cs497/

Smalltalk Best Practice Patterns, Beck

Reading

Smalltalk by Example, Alex Sharp,

- Chapter 4 Variables
- Chapter 5 Instance Creation

Inheritance

Smalltalk supports only single inheritance

Each class has single parent class

A class inherits (or has) all
- Methods defined in its parent class
- Methods defined in its grandparent class
- etc.
- Methods defined in any ancestor class
- Variables defined in any ancestor class

Terms

Parent Class
Superclass

Child class
Subclass

Object

Is the ancestor of all classes

Has no parent class

Contains important methods for all classes & objects

Inheritance and Name Clashes

Subclass can implement methods with same name as parent

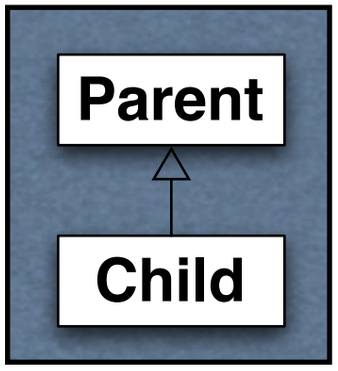
This is called overloading the method

When message is sent to instance of the subclass, the subclass method is used

Subclass can not overload variable names

Actually you can force a subclass to overload a variable name. Nothing good comes from doing this.

Example




```
Parent>>foo
    ^'foo'

Child>>foo
    ^'bar'
```

	Result
| aParent aChild |	
aParent := Parent new.	
aChild := Child new.	
aParent foo.	'foo'
aChild foo.	'bar'

Types of Variables

Temporary (Local) Variable
Named Instance Variable
Class Instance Variable
Shared Variable
Indexed Instance Variable

Temporary (Local) Variable

```
| a b sum |
a := 5.
b := 10.
sum := a + b.
```

```
Point>>grid: aPoint
    "Answer a new Point to the nearest rounded grid modules
    specified by aPoint."
    | newX newY |
    aPoint x = 0
        ifTrue:   [newX := 0]
        ifFalse:   [newX := x roundTo: aPoint x].
    aPoint y = 0
        ifTrue:   [newY := 0]
        ifFalse:   [newY := y roundTo: aPoint y].
    ^newX @ newY
```

Usage Convention

Do not use the same temporary variable name within a scope for more than one purpose

```
| aRecord |
aRecord := self indexRecord.
aRecord lock: 12.
aRecord := aRecord at: 12.
self update: (aRecord at: 1) with: self newData.
aRecord unlock: 12.
```


From Smalltalk With Style, page 20. Reusing the variable here caused an error - unlocking the wrong record.

Named Instance Variable

Each object has its own copy of a named instance variable

Like

- Protected C++ data member
- Protected Java field

Accessible by

- Instance methods of the class
- Instance methods of subclasses of the class

Not accessible by

- Methods in non-subclasses
- Class methods

Example

```
Smalltalk defineClass: #ClassPoint
        superclass: #{Core.Object}
        indexedType: #none
        private: false
        instanceVariableNames: 'x y '
        classInstanceVariableNames: ''
        imports: ''
        category: ''
```

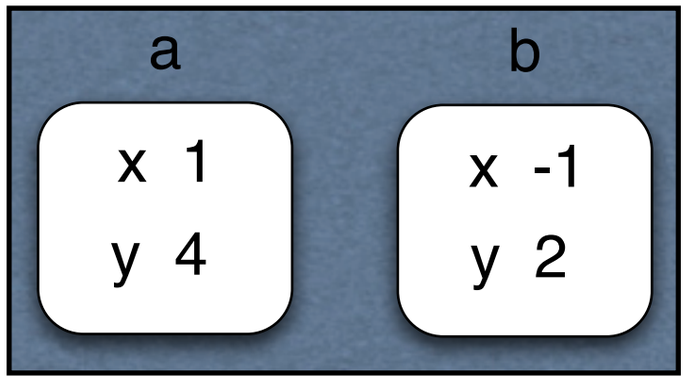
```
ClassPoint >>y: aNumber
        y := aNumber

ClassPoint >>x: aNumber
        x := aNumber
```


We now have two point objects. Each point object has a local copy of x and y. Values in the local copies are different.

Example

```
| a b |
a := ClassPoint new.
a
   x: 1;
   y: 4.
b := ClassPoint new.
b
   x: -1;
   y: 2.
```



We now have two point objects. Each point object has a local copy of x and y. Values in the local copies are different.

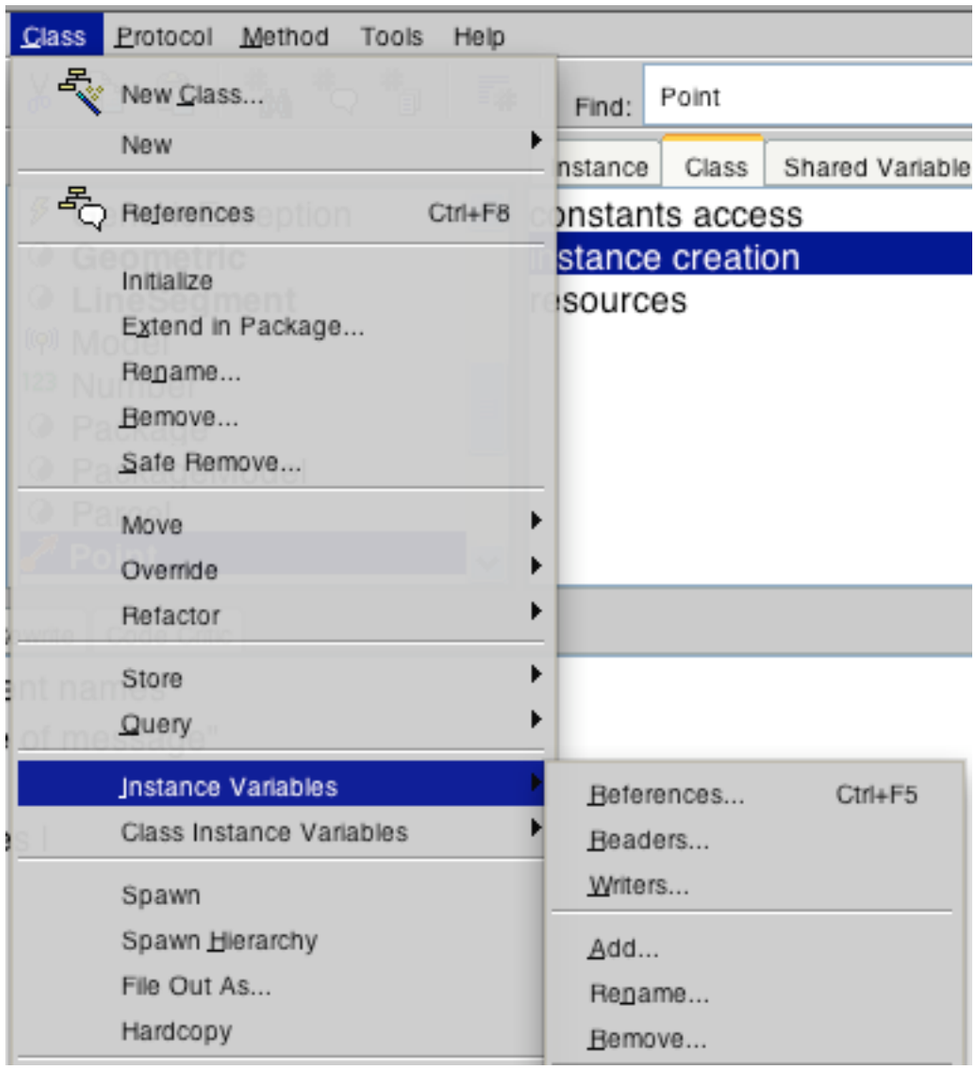
Adding Removing Instance Variables

Method 1 Edit Class Definition

```
Smalltalk defineClass: #ClassPoint
        superclass: #{Core.Object}
        indexedType: #none
        private: false
        instanceVariableNames: 'x y z w '
        classInstanceVariableNames: ''
        imports: ''
        category: ''
```

Adding/Removing Instance Variables

Method 2: Use Browser's Class menu



When removing instance variables using the menu option will check to see if you are still using the variable before removing it.

self & super

self

Refers to the receiver of the message (current object)

Methods referenced through self are found by:

Searching the class hierarchy starting with the class of receiver

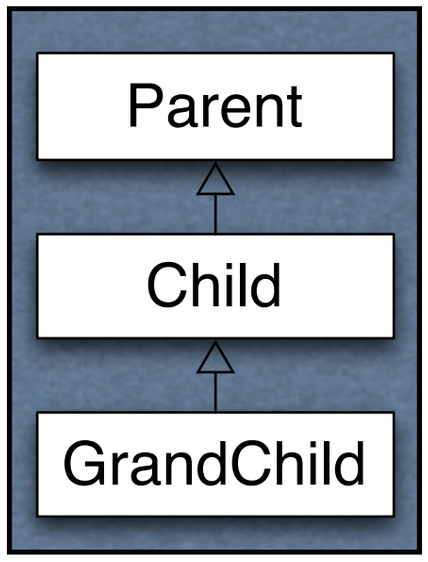
super

Refers to the receiver of the message (current object)

Methods referenced through super are found by:

Searching the class hierarchy starting the superclass of the class containing the method that references super

self and super Example




```
Parent>>name
   ^'Parent'
```

```
Child>>name
   ^'Child'

Child>>selfName
   ^self name

Child>>superName
   ^super name
```

```
GrandChild>>name
   ^'GrandChild'
```

Code	Output
| grandchild |	
grandchild := Grandchild new.	
Transcript	
show: grandchild name;	Grandchild
cr;	
show: grandchild selfName;	Grandchild
cr;	
show: grandchild superName;	Parent
cr;	

How does this work

grandchild selfName

Receiver is grandchild object
Code in selfName method is ^self name
To find the method "self name" start search in Grandchild class

grandchild superName

Receiver is grandchild object
Code in superName method is ^super name
superName is implemented in Child class

To find the method "super name" start search in the superclass of Child

Why Super

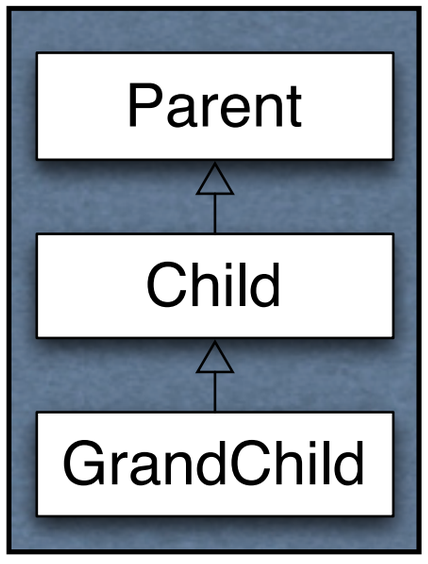
Super is used when:

The child class overrides a method
Needs to call overridden method

Common Pattern

```
ClassPointSubclass>>initialize
    super initialize.
    z := 0.
```

Why doesn't super refer to parent class of the receiver?




```
Parent>>name
   ^'Parent'
```

```
Child>>name
   ^super name , 'Child'
```

```
| trouble |
trouble := Grandchild new.
Transcript
    show: grandchild name;
```


If super referred to the parent class of the receiver the above code would result in an infinite loop. The receiver is a GrandChild object so the parent is Child. So in Child>>name "super name" would refer to Child>>name.

Class Methods

```
ClassPoint class>>origin
	^self x: 0 y: 0

ClassPoint class>>x: xNumber y: yNumber
	^(self new)
		x: xNumber;
		y: yNumber;
		yourself

ClassPoint class>>new
	^super new initialize
```

```
center := ClassPoint origin.
center x
"Returns o"
```

new & initialize

```
ClassPoint>>initialize
    x := 0.
        y := 0.
```

```
ClassPoint class>>new
        ^super new initialize
```

ClassPoint new

↓

SomeParentClass new initialize

↓

aClassPointObject initialize

SomeParentClass new returns a ClassPoint object

Initialization and Inheritance

```
Smalltalk.Core defineClass: #Parent
   superclass: #{Core.Object}
   instanceVariableNames: 'foo '
```

Class Method

```
new
   ^super new initialize
```

Instance Methods

```
initialize
   foo :=6.

foo
   ^foo
```

Initialization of Subclass

How to initialize bar?

```
Smalltalk.Core defineClass: #Child
   superclass: #{Core.Parent}
   instanceVariableNames: 'bar '
```

Bad Idea 1 – Use Same pattern

```
Child class>>new
   ^super new initialize

Child>>initialize
   bar := 2.

Child>>bar
   ^bar
```

Why bad?

Does not work!

```
| test |
test := Child new.
test foo “returns nil”
```

initialize is called twice

Child class>>new is not needed

Child class inherits an identical method

Bad Idea 2 – Subclass initializes Parent Variable

```
Child>>initialize
   bar := 2.
   foo := 6.
```

Why Bad?

Child class now involved in private affairs of the Parent

Changes to the Parent instance variables require changing Child

Solution

```
Parent class>>new
   ^super new initialize

Parent>>initialize
   foo :=6.

Parent>>foo
   ^foo
```

```
Child>>initialize
   super initialize
   bar := 2.

Child>>bar
   ^bar
```

Class Methods that Create Instances

Smalltalk does not have constructors like C++/Java

Use class methods to create instances

Place these class methods in "instance creation" category

Initial State of Instances

Create objects in some well-formed state

Class creation methods should:

- Have parameters for initial values of instance variables or
- Set default values for instance variables

Provide an instance method that:

- Sets the initial values of instance variables
- Place method in "initialize" or "initialize - release" category
- Use the name setVariable1: value variable2: ...

Disabling new

Point new

Does not work

Point x: 1 y: 12

This works

Point class>>new

^self shouldNotImplement

Implementers wanted users to specify initial value of a point

Actually the method is in the parent class of Point.

Class Instance Variables

A class has one instance of a class instance variable

Each subclass has a different instance

Accessible by

- Class methods of the class
- Class methods of subclasses

Example

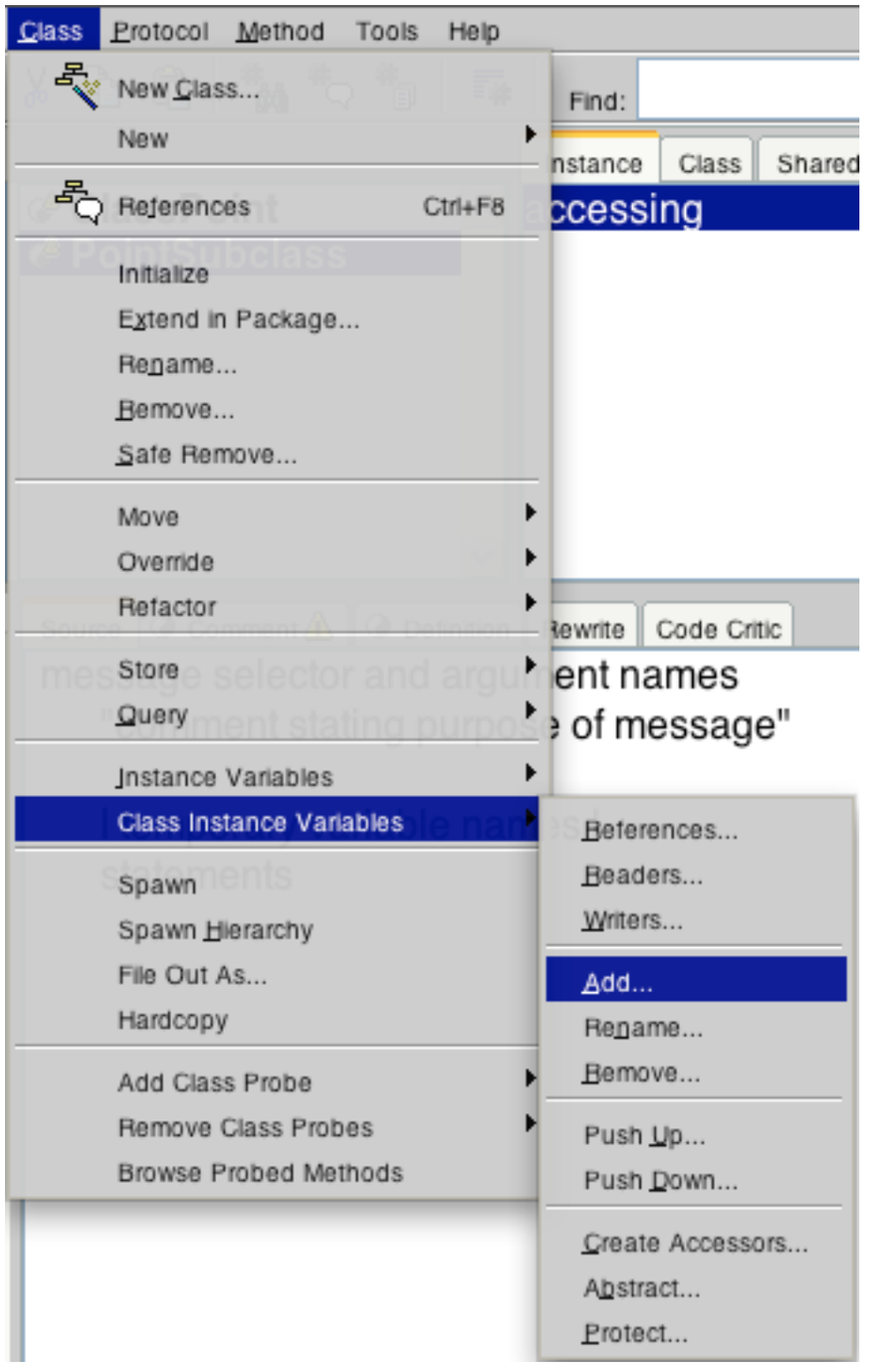
```
Smalltalk.Core defineClass: #ClassInstanceVariableExample
   superclass: #{Core.Object}
   indexedType: #none
   private: false
   instanceVariableNames: ''
   classInstanceVariableNames: 'test '
   imports: ''
   category: 'As yet unclassified'
```

Adding/Removing Class Instance Variables

Method 1

Edit the class definition directly

Method 2



Example

```
Smalltalk.Core defineClass: #Parent
   superclass: #{Core.Object}
   classInstanceVariableNames: 'test '

Parent class>>test
   test isNil ifTrue:[ test := 0].
   test := test + 1.
   ^test

Smalltalk.Core defineClass: #Child
   superclass: #{Core.Parent}
   classInstanceVariableNames: ''
```

Transcript	
print: Parent test;	1
cr;	
print: Parent test;	2
cr;	
print: Child test;	1
flush	

Lazy Initialization

```
Parent class>>test
   test isNil ifTrue:[ test := 0].
   test := test + 1.
   ^test
```

Indexed Instance Variable

Provides slots in objects for array like indexing

Used for Arrays

I have never added indexed instance variables

I have always used existing collection classes