CS 535 Object-Oriented Programming & Design
Fall Semester, 2010
Doc 5 Control Messages & Classes
Sept 7 2010

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

Smalltalk With Style, Klimas, Skublics, Thomas

Reading

Smalltalk by Example, Alex Sharp,

- Chapter 2 Methods
- Chapter 8 Control Structures
- Chapter 4 Variables
- Chapter 5 Instance Creation

Control Messages

if

(boolean expression) ifTrue: trueBlock

(boolean expression) ifFalse: falseBlock

(boolean expression) ifFalse: falseBlock ifTrue: trueBlock

(boolean expression) ifTrue: trueBlock ifFalse: falseBlock

```
a < 1 ifTrue: [Transcript show: 'hi mom' ]

difference := (x > y)
    ifTrue: [ x - y]
    ifFalse: [ y - x]
```

Boolean Expressions

	Symbol	Example
Or	|	a | b
And	&	a & b
Exclusive or	xor:	a xor: (b > c)
Negation	not	(a< b) not

Lazy Logical Operations

	Message	Example
Or	or: aBlock	a or: [b > c]
And	and: aBlock	a and: [c | b]

This is not C

This is a runtime error

```
5 ifTrue: [1 + 3]
```

Of course you could just add the ifTrue: method to the Number class if you want to do the above.

A Style Issue

Both do the same thing

```
difference := (x > y)
     ifTrue: [ x - y]
     ifFalse: [ y - x]
```

```
(x > y)
   ifTrue: [difference := x - y]
   ifFalse: [difference := y - x]
```

The one on the left may seem strange. Other language do allow this. Some (many Smalltalkers) consider the one on the left to better convey the intent of the code.

isNil

Answers true if receiver is nil otherwise answers false

```
x isNil
   ifTrue: [ do something]
   ifFalse: [ do something else]
```

Shortcuts

```
ifNil:ifNotNil:
ifNotNil:ifNil:
ifNil:
ifNotNil:

x
   ifNil: [ do something]
   ifNotNil: [ do something else]
```

Blocks

A deferred sequence of actions – a function without a name

Can have 0 or more arguments

Executed when sent the message 'value'

Similar to

- Lisp's Lambda- Expression
- Erlang's funs
- Ruby's Blocks
- Python's lambda
- Anonymous functions

```
[:variable1 :variable2 ... :variableN |
    | blockTemporary1 blockTemporary2 ... blockTemporaryK |
    expression1.
    expression2.
    ...]
```

Blocks and Return Values

Blocks return the value of the last executed statement in the block

```
| block x |
block := [:a :b |
        | c |
        c := a + b.
        c + 5].
x := block value: 1 value: 2.
```

x has the value 8

Blocks know their Environment

```
| a b |
a := 1.
b := 2.
aBlock := [a + b].
result := aBlock value
```

result is now 3

```
| a b |
a := 1.
b := 2.
aBlock := [a + b].
a := 5
result := aBlock value
```

result is now 6

Blocks and Arguments

Using the value: keyword message up to 4 arguments can be sent to a block.

```
[2 + 3 + 4 + 5] value
[:x | x + 3 + 4 + 5 ] value: 2
[:x :y | x + y + 4 + 5] value: 2 value: 3
[:x :y :z | x + y + z + 5] value: 2 value: 3 value: 4
[:x :y :z :w | x + y + z + w] value: 2 value: 3 value: 4 value: 5
```

valueWithArguments: can be used with 1 or more arguments

```
[:a :b :c :d :e | a + b + c + d + e ] valueWithArguments: #( 1 2 3 4 5)
[:a :b | a + b ] valueWithArguments: #( 1 2 )
```

Where is the Value Message

```
difference := (x > y)
    ifTrue: [ x - y]
    ifFalse: [ y - x]
```

In the False class we have:

```
ifTrue: trueAlternativeBlock ifFalse: falseAlternativeBlock
    ^falseAlternativeBlock value
```

In the True class we have:

```
ifTrue: trueAlternativeBlock ifFalse: falseAlternativeBlock
    ^trueAlternativeBlock value
```

This is an example of Polymorphism. More on this later.

While Loop

```
aBlockTest whileTrue
aBlockTest whileTrue: aBlockBody
aBlockTest whileFalse
aBlockTest whileFalse: aBlockBody
```

The last expression in aBlockTest must evaluate to a boolean

```
| x y difference |
x := 8.
y := 6.
difference := 0.
[x > y] whileTrue:
  [difference := difference + 1.
  y := y + 1].
^difference
```

```
| count |
count := 0.
[count := count + 1.
count < 100] whileTrue.
Transcript
      clear;
      show: count printString
```

More Loops

```
Transcript
   clear.
3 timesRepeat:
   [Transcript
      cr;
      show: 'Testing!'].
1 to: 3 do:
   [ :n |
   Transcript
      cr;
      show: n printString;
      tab;
      show: n squared printString].
9 to: 1 by: -2 do:
   [ :n |
   Transcript
      cr;
      show: n printString].
```

Transcript

```

Testing!
Testing!
Testing!
1    1
2    4
3    9
9
7
5
3
1
```

Classes

Objects & Classes - Smalltalk Language Details

Items to cover

Defining classes

Packages

Namespaces

Class names

Methods

- Instance
- Class

Variables

- Instance variables
- Class instance variables
- Shared variables

Inheritance

self & super

The Rules

Everything in Smalltalk is an object

All actions are done by sending a message to an object

Every object is an instance of a class

All classes have a parent class

Object is the root class

How do you Define a Class?

The previous slide gives the answer but you may not believe it.

Defining Point Class

```
Smalltalk.Core defineClass: #Point
        superclass: #{Core.ArithmeticValue}
        indexedType: #none
        private: false
        instanceVariableNames: 'x y '
        classInstanceVariableNames: ''
        imports: ''
        category: 'Graphics-Geometry'
```

Using the rules we send a message to an object. In this case we sent a message to the Namespace object that the class belongs. Some argue that we should sent a message to the classes parent (or super class). There are parts of the message that will not make sense now. Don't worry one does not have to type message. The browser will do it for you.

Terms

Superclass

Package (parcel)

Namespace

Class Names & Namespaces

Classes are defined in a namespace

Classes in different namespaces can use the same name

Full name of a class includes namespace

Root.Smalltalk.Core.Point

Use import to use shorter names

Workspace windows import all namespaces

Methods

All methods return a value

All methods are public

- Placed a method in the "private" category to tell others to treat it as private

Instance methods

Sent to instances of Classes

```
1 + 2
'this is a string' reverse
```

Class Methods

Sent to Classes

Commonly used to create instances of the class

```
Array new
Point x: 1 y: 3
Float pi
```

Convention

ClassName>>methodName

String>>reverse

Point class>>x:y:

Naming Conventions

Class Names

Use complete words, no abbreviations

First character of each word is capitalized

SmallInteger
LimitedWriteStream
LinkedMessageSet

Simple Superclass Name

Simple words

One word preferred, two at maximum

Convey class purpose in the design

Number
Collection
Magnitude
Model

Qualified Subclass Name

Unique simple name that conveys class purpose

- When name is commonly used

  Array
  Number
  String

Prepend an adjective to superclass name

- Subclass is conceptually a variation on the superclass

  OrderedCollection
  LargeInteger
  CompositeCommand

Class Names and Implementation

Avoid names that imply anything about the implementation of a class

"A proper name that is stored as a String"

ProperName
~~ProperNameString~~

"A database for Problem Reports that uses a Dictionary"

ProblemReportDatabase
~~ProblemReportDictionary~~

"Not implemented with a Set, it is a specialized Set"

SortedSet

Examples from Smalltalk With Style, page 5

Method Names

Always begins with a lowercase first letter

Don't abbreviate method names

Use uppercase letters for each word after the first

Method Naming Guidelines

Choose method names so that statements containing the method read like a sentence

```
FileDescpriptor seekTo: work from: self position
```

Use imperative verbs and phrases for methods which perform an action

```
Dog
    sit;
    lieDown;
    playDead.
```

```
aFace lookSuprised
```

~~aFace surprised~~

Examples from Smalltalk With Style, page 10-11

Method Naming Guidelines

Use a phrase beginning with a verb (is, has) when a method returns a boolean

isString

aPerson isHungry

~~aPerson hungry~~

Use common nouns for methods which answer a specific object

anAuctionBlock nextItem

~~anAuctionBlock item~~ "which item"

From Smalltalk With Style, page 11-12

Method Naming Guidelines

Methods that get/set a variable should use the same name as the variable

```
books
    ^books

~~getBooks~~
    ^books
```

```
books: aCollection
    books := aCollection

~~setBooks: aCollection~~
    books := aCollection
```

From Smalltalk With Style, page 15-16

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	Child class
Superclass	Subclass

Object

Is the ancestor of all classes

Has no parent class

Contains important methods for all classes & objects

Inheritance and Name Clashes

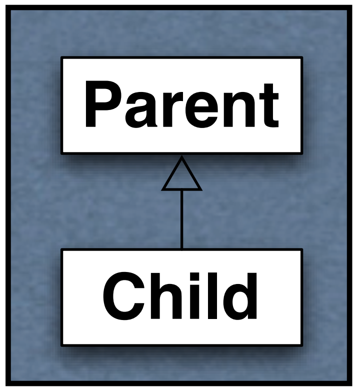
Subclass can implement methods with same name as parent

- 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

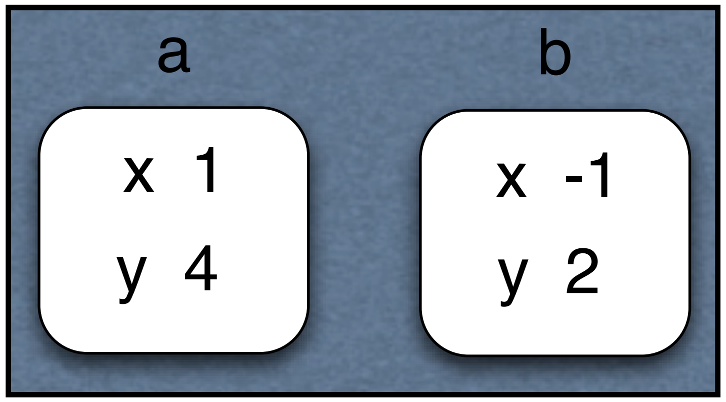
```
Smalltalk defineClass: #ClassPoint
	superclass: #{Core.Object}
	indexedType: #none
	private: false
	instanceVariableNames: 'x y '
	classInstanceVariableNames: ''
	imports: ''
	category: ''
```

```
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.

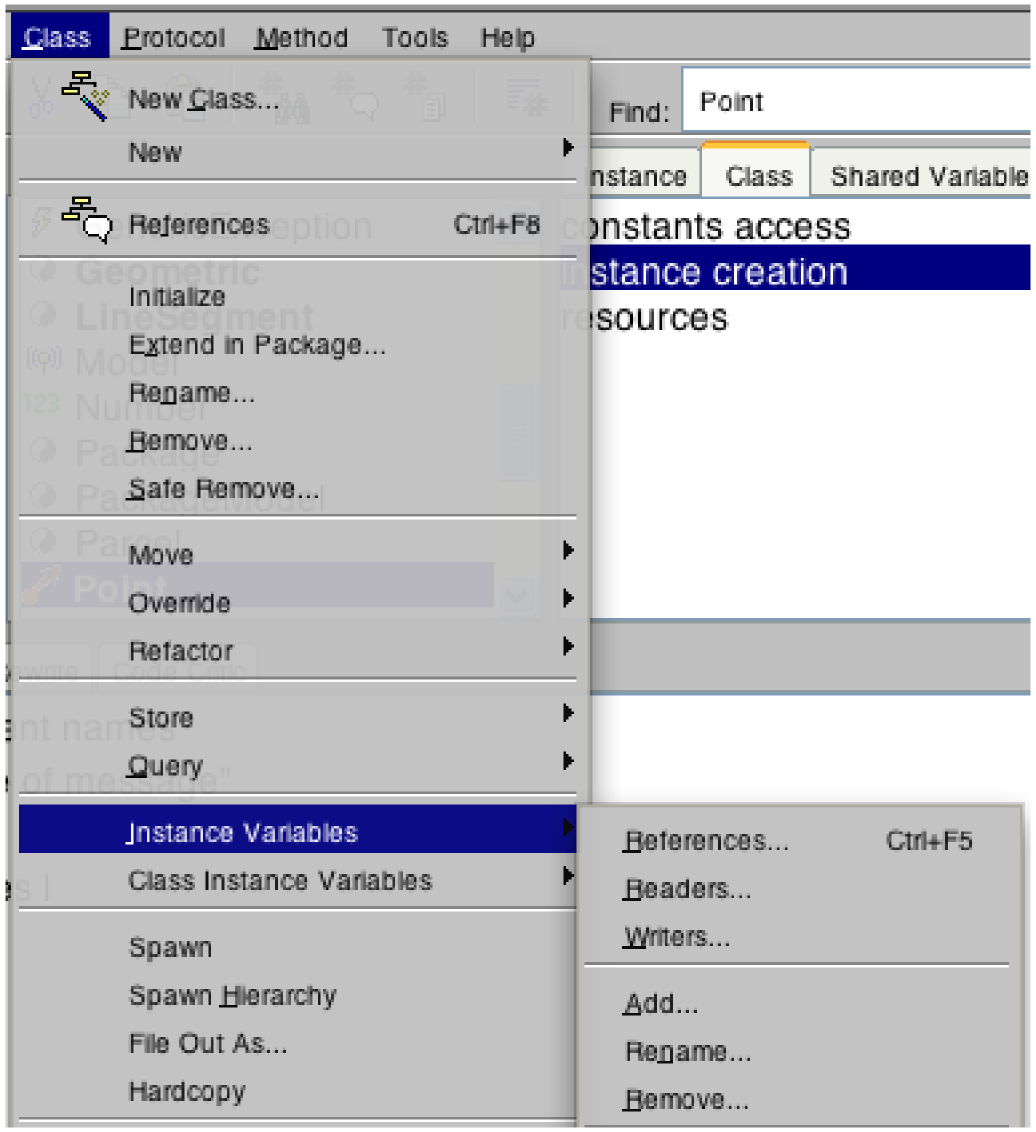
Adding Removing Instance Variables

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

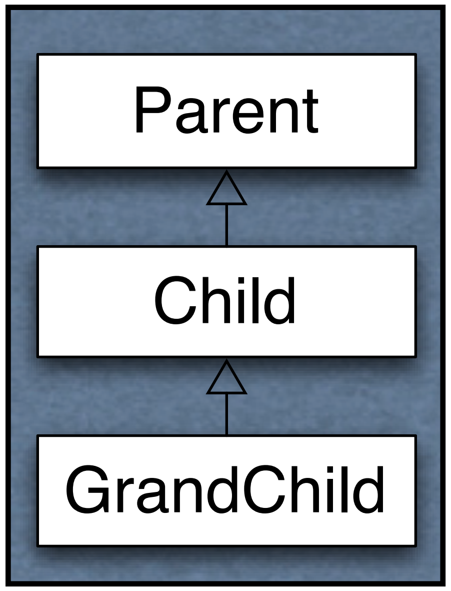
super

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:

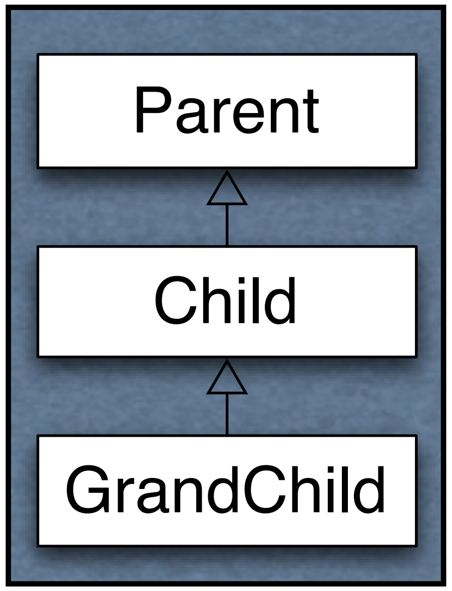
The child class overrides a method

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

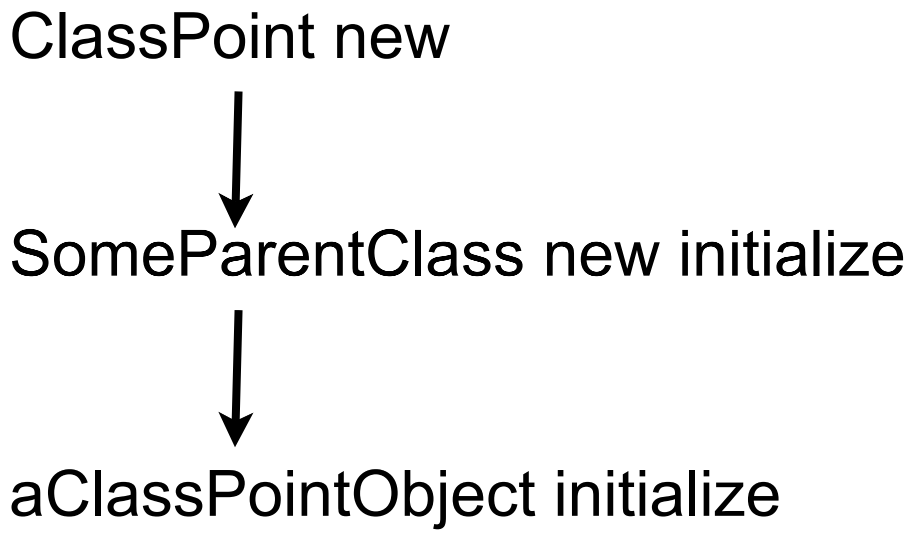
```
ClassPoint class>>origin
    ^self x: 0 y: 0

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

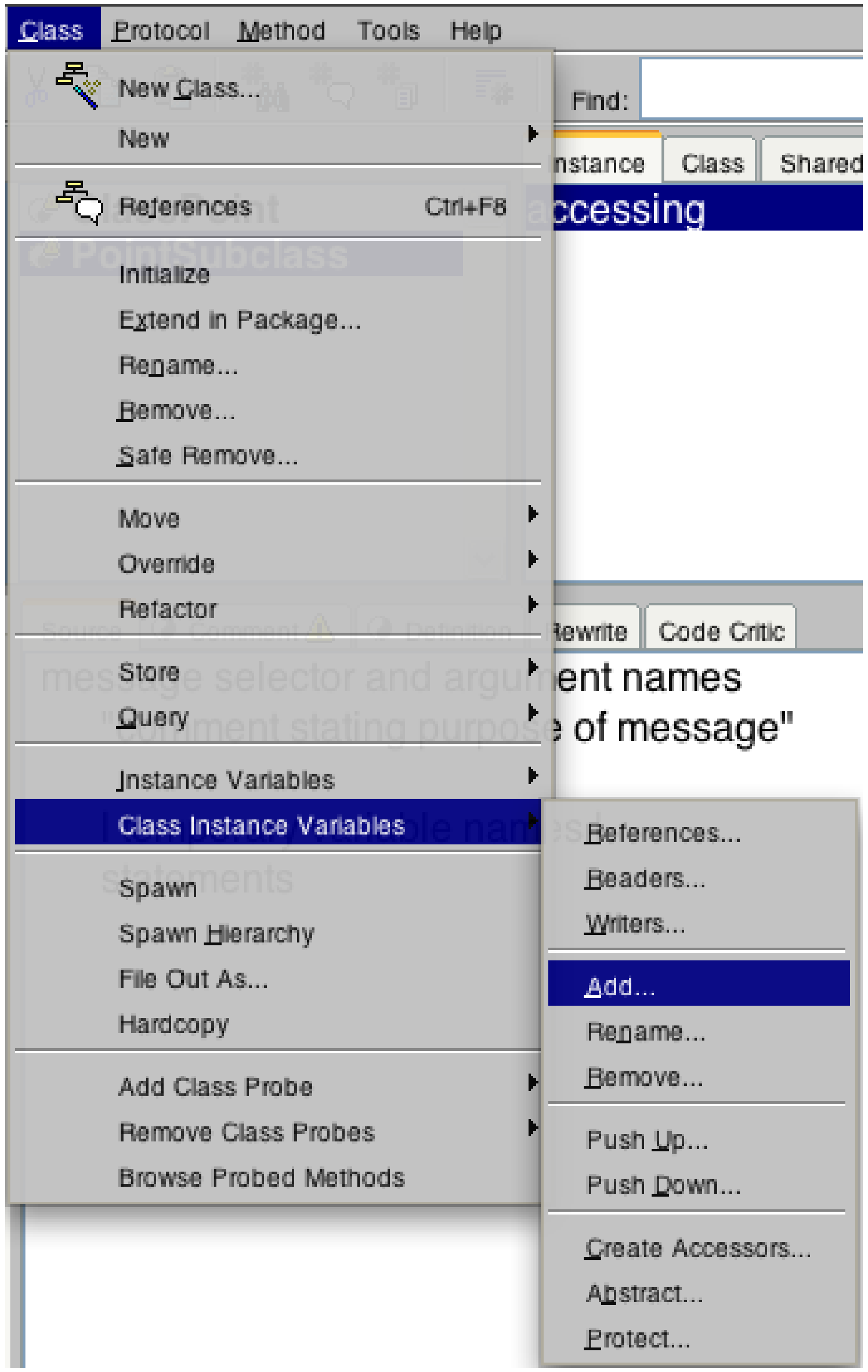
```
Smalltalk.Core defineClass: #ClassInstanceVariableExample
   superclass: #{Core.Object}
   indexedType: #none
   private: false
   instanceVariableNames: ''
   classInstanceVariableNames: 'test '
   imports: ''
   category: 'As yet unclassified'
```

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