CS 535 Object-Oriented Programming & Design
Spring Semester, 2003
Doc 4 Classes Part 2
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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

VisualWorks Application Developer's Guide, Chapter 2 and 4. The VisualWorks Application Developer's Guide is the file AppDevGuide.pdf in the docs directory of the VisualWorks directory. On Rohan this file is /opt/smalltalk/vw7nc/doc/AppDevGuide.pdf

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VisualWorks Menu Shortcut

When you install VisualWorks on Windows it creates a short cut on the start menu

This short cut only opens the image called visual.im in the image directory

If you save an image under a different name you will not be able to use that image using the start menu short cut

I never use the start menu short cut for VisualWorks

I always start VisualWorks by double-clicking on the image I wish to run

The first time I have to bind the image file to visual.exe

Objects & Classes - Smalltalk Language Details

Items to cover:

Class names

Methods
- Instance
- Class

Variables
- Instance variables
- Class instance variables
- Shared variables

Inheritance

self & super

Class Names

Smalltalk class names:

Use complete words, no abbreviations

Names are read 100 to 1000 times more often than typed

Abbreviations waste more time (reading) than they save

First character of each word is capitalized

SmallInteger, LimitedWriteStream, LinkedMessageSet

Simple Superclass Name

Superclass names

- 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

If name is in common use

Array, Number, String

If the purpose is more important that class hierarchy

Prepend an adjective to superclass name

If the class hierarchy is important

Subclass is conceptually a variation on the superclass

OrderedCollection, LargeInteger, CompositeCommand

Class Names & Namespaces

Classes are defined in a namespace

Allows classes in different namespaces to use the same name

Full name of a class includes namespace

Root.Smalltalk.Core.Point is full name of Point class

The import mechanism allows one to use shorter names

Workspace windows import all namespaces

Point Name Example

Each of the following is legal code in a workspace

```
Root.Smalltalk.Core.Point
    x: 1
    y: 1.

Smalltalk.Core.Point
    x: 1
    y: 1.

Core.Point
    x: 1
    y: 1.

Point
    x: 1
    y: 1.
```

Methods

All methods are public

Methods considered private are placed in the method category called "private"

All methods return a value

Instance methods

Sent to instances of Classes

Examples

```
1 + 2

'this is a string' reverse
```

Class methods

Sent to Classes

Can not be sent directly to instance of the class

Commonly used to create instances of the class

Examples

Point new

Point x: 1 y: 3

Float pi

Variables

Types of Variables

Named Instance Variable
Class Instance Variable
Shared Variable
Temporary Variable
Indexed Instance Variable

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

x & y are instance variables

```
| a b |
a := Point
   x: 1
   y: 4.
b := Point
   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.

Accessing Instance variables in an Instance method

Point instance method example

```
Point>>dotProduct: aPoint

   ^(x* aPoint x) +  (y * aPoint y)
```

Adding an Instance Variables to a Class

To add an instance variable to a class,

Add the variable name in the string argument of instanceVariableNames:

Example

To add a z to the point class, just add z to the string

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

Removing an Instance Variables to a Class

Remove the variable name from the class definition

Make sure no methods still use the variable

Class Instance Variable

A class has one instance

Each subclass has a different instance

Accessible by
- Class methods
- Class methods of subclasses

Example
Class Definitions

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

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

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

The Test

```
ClassInstanceVariableExample test.
Transcript
   print: ClassInstanceVariableExample test;
   cr;
   print: ClassInstanceVariableChild test;
   cr;
   flush
```

Output in Transcript

```
2
1
```

Shared Variables

Only one copy exists of each shared variable

Multiple classes and object can access the same shared variable

Adding a Shared Variable to a Class

In a browser select an existing class.

Click on the "shared variables" radio button in the browser

Now use the "Protocol" menu to add a new category for the shared variables

You get the template

```
SharedVariableClass defineSharedVariable: #NameOfBinding
   private: false
   constant: false
   category: 'accessing'
   initializer: 'Array new: 5'
```

Change NameOfBinding to the name of the variable

Keep the "#" before the name

Change the other values as appropriate

Private and Public Shared Variables

A shared variable can be accessed from any class

Private shared variable access

- In the class just use short name of the variable
- Outside the class use the fully qualified name

Public shared variable access

- In the class & subclasses use short name
- Outside the class
  - Use fully qualified name or
  - Use import to shorten the name

Private does not seem to be the correct term

Example

```
Smalltalk.Core defineClass: #SharedVariableExample
   superclass: #{Core.Object}
   indexedType: #none
   private: false
   instanceVariableNames: ''
   classInstanceVariableNames: ''
   imports: ''
   category: 'Course-Examples'

Core.SharedVariableExample defineSharedVariable: #PublicVariable
   private: false
   constant: false
   category: 'data'
   initializer: '3'

Core.SharedVariableExample defineSharedVariable: #PrivateVariable
   private: true
   constant: false
   category: 'data'
   initializer: '5'
```

SharedVariableExample Instance Methods

```
privateVariable
   ^PrivateVariable

privateVariable: anObject
   PrivateVariable := anObject

publicVariable
   ^PublicVariable

publicVariable: anObject
   PublicVariable := anObject
```

Subclass Accessing Shared Variables

```
Smalltalk.Core defineClass: #SharedVariableChild
   superclass: #{Core.SharedVariableExample}
   indexedType: #none
   private: false
   instanceVariableNames: ''
   classInstanceVariableNames: ''
   imports: ''
   category: 'Course-Examples'

Core.SharedVariableChild methodsFor: 'accessing'

childPublic
   ^PublicVariable

childPrivate
   "Subclass can not use short name on private"
   ^Core.SharedVariableExample.PrivateVariable
```

Other Class Accessing Shared Variables

```
Smalltalk.Core defineClass: #SharedVariableUser
   superclass: #{Core.Object}
   indexedType: #none
   private: false
   instanceVariableNames: ''
   classInstanceVariableNames: ''
   imports: '
         Core.SharedVariableExample.*
         '
   category: 'Course-Examples'

Core.SharedVariableUser methodsFor: 'accessing'

privateVariable
   "Can not use short name on private variables"
   ^Core.SharedVariableExample.PrivateVariable

publicVariable
   ^PublicVariable
```

Initializing Shared Variables

```
Core.SharedVariableExample defineSharedVariable: #PublicVariable
   private: false
   constant: false
   category: 'data'
   initializer: '3'
```

Shared variables have an initializer

The initializer by:

"Initialize Variable" item in the browser "Method" menu
Sending a message

```
#{Core.SharedVariableExample.PublicVariable} initialize
```

Constant Verses Non-Constant Shared Variables

A constant shared variable's value:

Is set by an initializer
Can not be changed by assigning a new value

Non-constant shared variable's value can changed

```
Core.SharedVariableExample.PublicVariable := 42.
```

Some Existing Uses of Shared Variables

Transcript

A shared variable

An object that writes to a window

Character Constants

Where are tab, space, cr, lf defined?

Solution one - Class methods of Character

Character cr
Character space
Character lf

Works, but is verbose

Solution Two - Shared Variables

Graphics.TextConstants defines shared variables

Tab, CR, LF, Space

To use in a class import "Graphics.TextConstants.*"

Indexed Instance Variable

Provides slots in objects for array like indexing

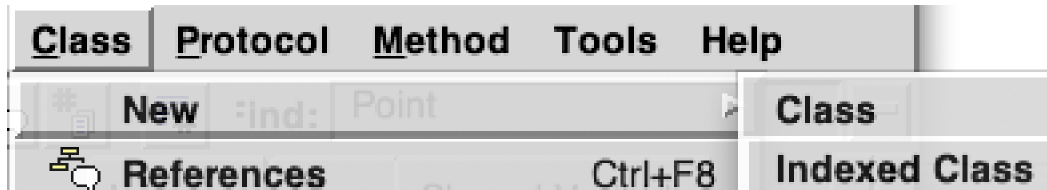
Used for Arrays

I have never added indexed instance variables

I have always used existing collection classes

Adding Indexed Instance Variables to a Class

Create a class using Class:Add Class:Indexed menu item in the browser.



You get the template somewhat like:

```
Core defineClass: #NameOfClass
   superclass: #{NameOfSuperclass}
   indexedType: #objects
   private: false
   instanceVariableNames: 'instVarName1 instVarName2'
   classInstanceVariableNames: ''
   imports: ''
   category: 'Course-Examples'
```

For this example I edited the template to be:

```
Core defineClass: #IndexedExample
   superclass: #{Core.Object}
   indexedType: #objects
   private: false
   instanceVariableNames: ''
   classInstanceVariableNames: ''
   imports: ''
   category: 'Course-Examples'
```

Once this is saved the following works:

```
| a |

a := IndexedExample new: 10.
a
   at: 1 put: 2.
^a
```

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

Some Terminology

Parent Class
Superclass
Base Class

Mean same thing

Child class
Subclass
Derived class

Mean the same thing

Class "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

Special or PseudoVariables

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

Called pseudo-variables because:

They do change value
You can not assign values to them

Self, Super Example

Three classes to study self & super: Parent, Child, GrandChild

Parent

```
Smalltalk.Core defineClass: #Parent
   superclass: #{Core.Object}
   indexedType: #none
   private: false
   instanceVariableNames: ''
   classInstanceVariableNames: ''
   imports: ''
   category: 'Course-Examples'
```

Instance Methods

```
name
   ^'Parent'
```

Child

```
Smalltalk.Core defineClass: #Child
   superclass: #{Core.Parent}
   indexedType: #none
   private: false
   instanceVariableNames: ''
   classInstanceVariableNames: ''
   imports: ''
   category: 'Course-Examples'
```

Instance Methods

```
name
   ^'Child'

selfName
   ^self name

superName
   ^super name
```

GrandChild

```
Smalltalk.Core defineClass: #GrandChild
   superclass: #{Core.Child}
   indexedType: #none
   private: false
   instanceVariableNames: ''
   classInstanceVariableNames: ''
   imports: ''
   category: 'Course-Examples'
```

GrandChild Instance Methods

```
name
   ^'GrandChild'
```

Self, Super Example - Continued

Test Program

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

Self, Super Example - Continued
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 self name start search in the superclass of Child

Why Super

Super is used when:

The child class extends the behavior of the inherited method

That is:

Child class inherits a method, call it foo
Child class implements a with the same name
Child class needs to access the inherited method

In this case super is needed access the inherited method

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

```
Object subclass #Parent

name
   ^'Parent'

Parent subclass #Child

name
   ^super name , 'Child'

Child subclass #Grandchild

"No methods in Grandchild"
```

Sample Program

```
| trouble |
trouble := Grandchild new.
trouble name.
```

Assume that super did refer to the parent class of the receiver. Sending the message "name" to trouble would call the code "super name , 'Child' ". The super would refer to the parent class of the receiver. Since the receiver is a Grandchild object, "super name" would refer to the "name" method in the Parent class. Hence the method will call itself with no way to end.

Implicit Return Values

If a method does not explicitly return a value, self is returned

Hence a method like:

```
decrease
   count ifNil: [count := 0].
   count := count - 1
```

Is really:

```
decrease
   count ifNil: [count := 0].
   count := count - 1.
   ^self
```

Style Issue - When to explicitly return?

Only explicitly return a value from a method when the intent of the method is to return a value. An explicit return indicates to other programmers that the intent of the method is to compute some return value. The intent of the decrease method is to change the state of the receiver. Hence it should not have a value explicitly returned.

Initializing Instance Variables

If the instance variables always start at same value:

Create in instance method to initialize them
Implement class method "new" to initialize the object

```
Smalltalk.Core defineClass: #Counter
   superclass: #{Core.Object}
   indexedType: #none
   private: false
   instanceVariableNames: 'count '
   classInstanceVariableNames: ''
   imports: ''
   category: 'Course-Examples'
```

Instance Methods

Category: initialize

```
initialize
   count := 0
```

Category: access

```
count
   ^count

decrease
   count := count - 1

increase
   count := count + 1
```

Class Methods

Category: instance creation

```
new
   ^super new initialize
```

Example - Instance Creation with Parameters

```
Smalltalk.CS535 defineClass: #Counter
    superclass: #{Core.Object}
    indexedType: #none
    private: false
    instanceVariableNames: 'count '
    classInstanceVariableNames: ''
    imports: ''
    category: 'Course-Examples'
```

Instance Methods

Category: initialize

```
setCount: anInteger
    count := anInteger
```

Category: access

```
count
    ^count

decrease
    count := count - 1

increase
    count := count + 1
```

Example - Instance Creation with Parameters Continued

Class Methods

Category: instance creation

```
new
   ^self count: 0

count: anInteger
   ^super new setCount: anInteger
```

Category: examples

```
example
   "Counter example"   "or one can use self example"

   | a |
   a := Counter new.
   a
      increase;
      increase.
   ^a count
```

Class Methods that Create Instances
Some Guidelines[1]

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: …

[1] See Beck 1997, Constructor Method and Constructor Parameter Method patterns, pp. 21-24 and Johnson's class notes on Smalltalk Coding Standards

Beck's First Rule of Good Style[2]

"In a program written with good style,
everything is said once and only once"

Some violations of the rule:

Methods with the same logic
Classes with same the same methods
Systems with similar classes

Example

```
new
  ^self count: 0

count: anInteger
  ^super new setCount: anInteger
```

Not

```
new
  ^super new setCount: 0

count: anInteger
  ^super new setCount: anInteger
```

If the logic of creating a new instance changes, the first version only has one place to change.

---

[2] See Beck 1997, page 6

Providing Examples in Class Methods

A common Smalltalk practice is to provide

Class method(s) implementing example use of the class

Comment in the method to execute the example

Place such example methods in "example(s)" category

Category: examples

```
example
  "Counter example"

  | a |
  a := Counter new.
  a
    increase;
    increase.
  ^a count
```