Dynamic Object-Oriented Programming with Smalltalk

1. Introduction

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What is surprising about Smalltalk

> Everything is an object
> Everything happens by sending messages
> All the source code is there all the time
> You can't lose code
> You can change everything
> You can change things without restarting the system
> The Debugger is your Friend
Why Smalltalk?

> *Pure* object-oriented language and environment
  
  — “Everything is an object”

> Origin of *many innovations* in OO development
  
  — RDD, IDE, MVC, XUnit …

> Improves on many of its successors
  
  — Fully interactive and dynamic
What is Smalltalk?

> **Pure OO language**
  - Single inheritance
  - Dynamically typed

> **Language and environment**
  - Guiding principle: “Everything is an Object”
  - Class browser, debugger, inspector, …
  - Mature class library and tools

> **Virtual machine**
  - Objects exist in a persistent *image* [+ *changes*]
  - Incremental compilation
# Smalltalk vs. C++ vs. Java

<table>
<thead>
<tr>
<th></th>
<th>Smalltalk</th>
<th>C++</th>
<th>Java</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Object model</strong></td>
<td>Pure</td>
<td>Hybrid</td>
<td>Hybrid</td>
</tr>
<tr>
<td><strong>Garbage collection</strong></td>
<td>Automatic</td>
<td>Manual</td>
<td>Automatic</td>
</tr>
<tr>
<td><strong>Inheritance</strong></td>
<td>Single</td>
<td>Multiple</td>
<td>Single</td>
</tr>
<tr>
<td><strong>Types</strong></td>
<td>Dynamic</td>
<td>Static</td>
<td>Static</td>
</tr>
<tr>
<td><strong>Reflection</strong></td>
<td>Fully reflective</td>
<td>Introspection</td>
<td>Introspection</td>
</tr>
<tr>
<td><strong>Concurrency</strong></td>
<td>Semaphores, Monitors</td>
<td>Some libraries</td>
<td>Monitors</td>
</tr>
<tr>
<td><strong>Modules</strong></td>
<td>Categories, namespaces</td>
<td>Namespaces</td>
<td>Packages</td>
</tr>
</tbody>
</table>
Smalltalk: a State of Mind

> **Small and uniform language**
  > Syntax fits on one sheet of paper

> **Large library of reusable classes**
  > Basic Data Structures, GUI classes, Database Access, Internet, Graphics

> **Advanced development tools**
  > Browsers, GUI Builders, Inspectors, Change Management Tools, Crash Recovery Tools, Project Management Tools

> **Interactive virtual machine technology**
  > Truly platform-independent

> **Team Working Environment**
  > Releasing, versioning, deploying
Origins of Smalltalk

> **Project at Xerox PARC in 1970s**
  > Language and environment for new generation of graphical workstations (target: “Dynabook”)

> **In Smalltalk-72, every object was an independent entity**
  > Language was designed for children (!)
  > Evolved towards a meta-reflective architecture

> **Smalltalk-80 is the standard**
Smalltalk — The Inspiration

> **Flex** (Alan Kay, 1969)
> **Lisp** (Interpreter, Blocks, Garbage Collection)
> Turtle graphics (The **Logo** Project, Programming for Children)
> Direct Manipulation Interfaces (**Sketchpad**, Alan Sutherland, 1960)
> **NLS**, (Doug Engelbart, 1968), “the augmentation of human intellect”
> **Simula** (Classes and Message Sending)
> Xerox PARC (Palo Alto Research Center)
> **DynaBook**: a Laptop Computer for Children

— [www.smalltalk.org/smalltalk/TheEarlyHistoryOfSmalltalk_Abstract.html](http://www.smalltalk.org/smalltalk/TheEarlyHistoryOfSmalltalk_Abstract.html)
Dynabook Mockup

www.artmuseum.net/w2vr/archives/Kay/01_Dynabook.html
Alto: a Machine to Run Smalltalk

Smalltalk on Alto III
Precursor, Innovator & Visionary

> First to be based on Graphics
  — Multi-Windowing Environment (Overlapping Windows)
  — Integrated Development Environment: Debugger, Compiler, Text Editor, Browser
> With a pointing device ✶ yes, a Mouse
> Ideas were taken over
  — Apple Lisa, Mac
  — Microsoft Windows 1.0
> Platform-independent Virtual Machine
> Garbage Collector
> Just-in-time Compilation
> Everything was there, the complete Source Code
History
The History (External)

> 1980 — Smalltalk-80
    – ASCII, cleaning primitives for portability, metaclasses, blocks as first-class objects, MVC.
    – Projects: Gallery Editor (mixing text, painting and animations) + Alternate Reality Kit (physics simulation)

> 1981 — Books + 4 external virtual machines
    – Dec, Apple, HP and Tektronix
    – GC by generation scavenging

> 1988 — Creation of Parc Place Systems

> 1992 — ANSI Draft

> 1995 — New Smalltalk implementations
    – MT, Dolphin, Squeak, Smalltalk/X, GNU Smalltalk

> 2000 — Fscript, GNU Smalltalk, SmallScript

> 2002 — Smalltalk as OS: 128k ram
What are Squeak and Pharo?

> Squeak is a modern, open-source, highly portable, fast, full-featured Smalltalk implementation
  — Based on original Smalltalk-80 code

> Pharo is a lean and clean fork of Squeak
  — [www.pharo-project.org](http://www.pharo-project.org)
Smalltalk — Key Concepts

> **Everything is an object**
  - numbers, files, editors, compilers, points, tools, booleans …

> Everything happens by *sending messages*

> Every object is an instance of one class
  - which is also an object
  - A class defines the structure and the behavior of its instances.

> Objects have private (protected) state
  - Encapsulation boundary is the object

> Dynamic binding
  - Variables are dynamically typed and bound
Objects and Classes

> *Every object is an instance of a class*
  
  — A class specifies the structure and the behaviour of all its instances
  
  — Instances of a class share the same behavior and have a specific state
  
  — *Classes are objects* that create other instances
  
  — *Metaclases* are classes that create classes as instances
  
  — Metaclases describe class behaviour and state (subclasses, method dictionary, instance variables...)*
Messages and Methods

> **Message** — which action to perform

```smalltalk
aWorkstation accept: aPacket
aMonster eat: aCookie
```

> **Method** — how to carry out the action

```smalltalk
accept: aPacket
     (aPacket isAddressedTo: self)
     ifTrue:
         Transcript show:
             'A packet is accepted by the Workstation ',
             self name asString
     ifFalse: [super accept: aPacket]
```
Smalltalk Run-Time Architecture

> Virtual Machine + Image + Changes and Sources

All the objects of the system at a moment in time

- IMAGE1.IM
- IMAGE1.CHA

One per user

- IMAGE2.IM
- IMAGE2.CHA

A byte-code interpreter: the virtual machine interpretes the image

Standard SOURCES

Shared by everybody

> Image = bytecodes
> Sources and changes = code (text)
Smalltalk Run-Time Architecture

> Byte-code is translated to native code by a just-in-time compiler
  — Some Smalltalks, but not Pharo

> Source and changes are not needed to interpret the byte-code.
  — Just needed for development
  — Normally removed for deployment

> An application can be delivered as byte-code files that will be executed with a VM.
  — The development image is stripped to remove the unnecessary development components.
Mouse Semantics

Select

Operate

Window
World Menu
“Hello World”
The Smalltalk Browser
The Debugger

```
/ aNumber

"Primitive. This primitive (for /) divides the receiver by the argument and returns the result if the division is exact. Fail if the result is not a whole integer. Fail if the argument is 0 or is not a SmallInteger. Optional. No Lookup. See Object documentation whatIsAPrimitive."

<primitive: 10>
aNumber isZero ifTrue: [^(ZeroDivide dividend: self) signal].
^(aNumber isMemberOf: SmallInteger)
  ifTrue: [(Fraction numerator: self denominator: aNumber) reduced]
  ifFalse: [super / aNumber]
```
The Inspector
The Explorer
Other Tools

> File Browser
  — *Browse, import, open files*

> Method Finder, Message Name tool
  — *Find methods by name, behaviour*

> Change Sorter
  — *Name, organize all source code changes*

> SUnit Test Runner
  — *Manage & run unit tests*
File Browser

Here is a list of packages included in this Pharo1.0beta (#10418): AST-damiencassou.171
AutomaticMethodCategorizer-DF.25 AutomaticMethodCategorizerOB-DF.1
ImageForDevelopers-pharo-DamienCassou.189 Installer-Core-kph.324 NewInspector-DamienCassou.39
Nile-All-damiencassou.144 O2-Enhancements-DavidRoethlisbergr.3 O2-Morphic-DavidRoethlisbergr.2
O2-Standard-DavidRoethlisbergr.2 OB-Morphic-Ir.99 OB-Refactory-Ir.159 OB-Regex-Ir.19
OB-Standard-DamienCassou.429 OCForOB-rr.2 Ocompletion-damiencassou.33
OmniBrowser-DamienCassou.459 OmniBrowser2-DavidRoethlisbergr.2 Refactoring-Core-Ir.57
Refactoring-Spelling-Ir.6 RoelTyper-PF.74 Shout.3.15-damiencassou.73 ShoutWorkspace.1-tween.4
Message Name Finder

"Answer whether text matches the pattern in this string. Matching ignores upper/lower case differences. Where this string contains #, text may contain any character. Where this string contains *, text may contain any sequence of characters."

^self startingAt: 1 match: text startingAt: 1

'*' match: 'zort' true
'*baz' match: 'mobaz' true
'*baz' match: 'mobazo' false

Installer match:
NSCollectionStream match:
NSCompressedSourceStream match:
NSDecoderInflateStream match:
NSFileStream match:
NSTGettablePositionableStream match:
Parser match:
PositionableStream match:
RxCharSetParser match:
RxParser match:
String match:
Method Finder

Type a fragment of a selector in the top pane. Accept it.

Or, use an example to find a method in the system. Type receiver, args, and answer in the top pane with periods between the items. 3. 4. 7
Methods in ChangeSets & Versions
Preferences

If true, swaps some control- and alt-keys (making ctrl-c be copy instead of alt-c).

Cannot be true if duplicateControlAndAltKeys or duplicateAllControlAndAltKeys is true.
SUnit

![Test Runner](image)

Test Runner window showing test results for the Money package with 2 runs, 2 passes, 0 expected failures, 0 failures, 0 errors, and 0 unexpected passes.
What you should know!

- How does Smalltalk differ from Java or C++?
- Where are Smalltalk programs stored?
- Where are objects stored?
- What was the Dynabook?
- Is a class an object?
- What is dynamic binding?
- What is the difference between a message and a method?
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