

# 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

	<b><i>Smalltalk</i></b>	<b><i>C++</i></b>	<b><i>Java</i></b>
<i>Object model</i>	Pure	Hybrid	Hybrid
<i>Garbage collection</i>	Automatic	Manual	Automatic
<i>Inheritance</i>	Single	Multiple	Single
<i>Types</i>	Dynamic	Static	Static
<i>Reflection</i>	Fully reflective	Introspection	Introspection
<i>Concurrency</i>	Semaphores, Monitors	Some libraries	Monitors
<i>Modules</i>	Categories, namespaces	Namespaces	Packages

# 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

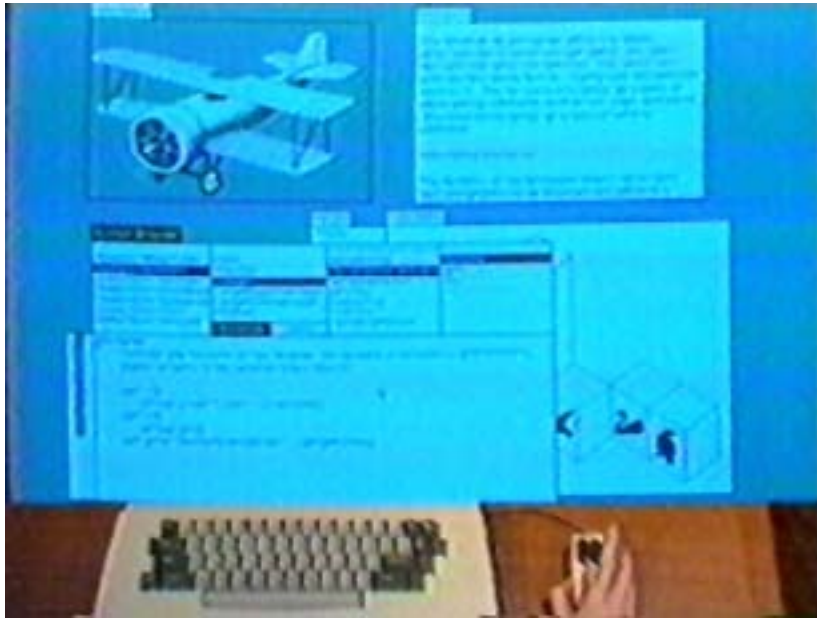
- > **Flex** (Alan Kay, 1969)
- > **Lisp** (Interpreter, Blocks, Garbage Collection)
- > Turtle graphics (The **Logo** Project, Programming for Children)
- > Direct Manipulation Interfaces (**Sketchpad**, Alan Sutherland, 1960)
- > **NLS**, (Doug Engelbart, 1968), “the augmentation of human intellect”
- > **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)






# 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

1950

1960

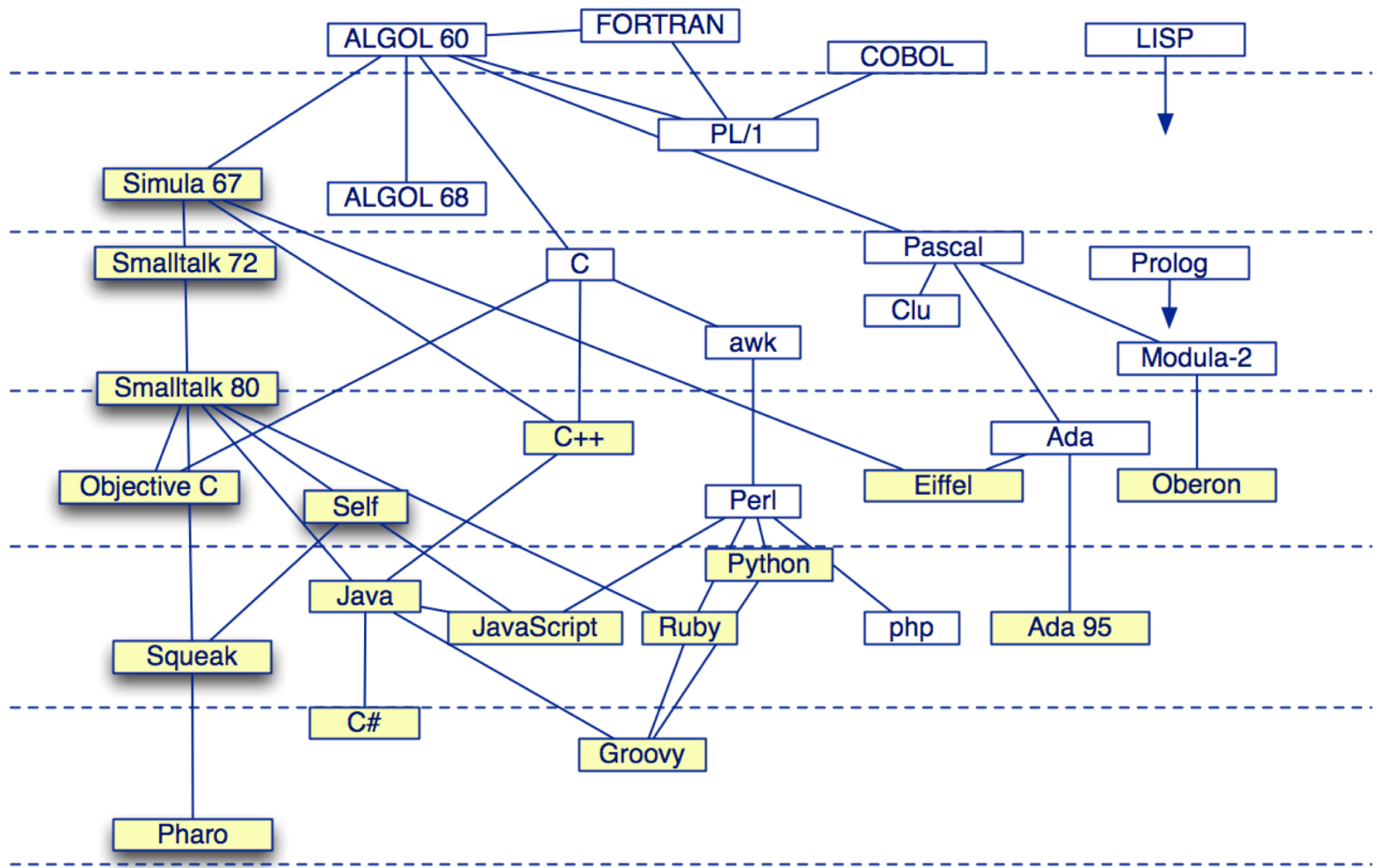
1970

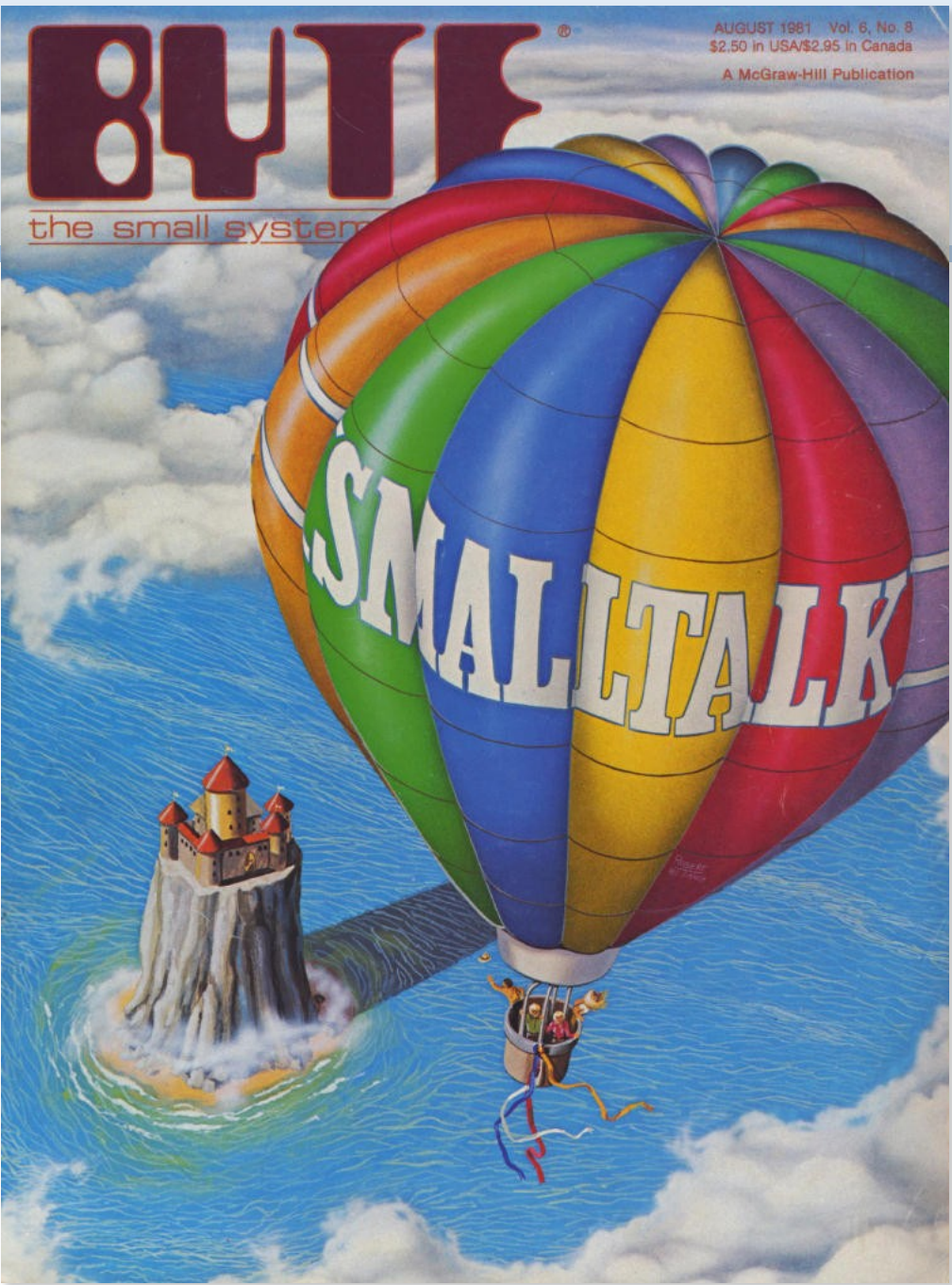
1980

1990

2000

2010







# 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
  - Metaclasses are classes that create classes as instances
  - Metaclasses describe class behaviour and state (subclasses, method dictionary, instance variables...)

# Messages and Methods

- > Message — which action to perform

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

- > Method — how to carry out the action

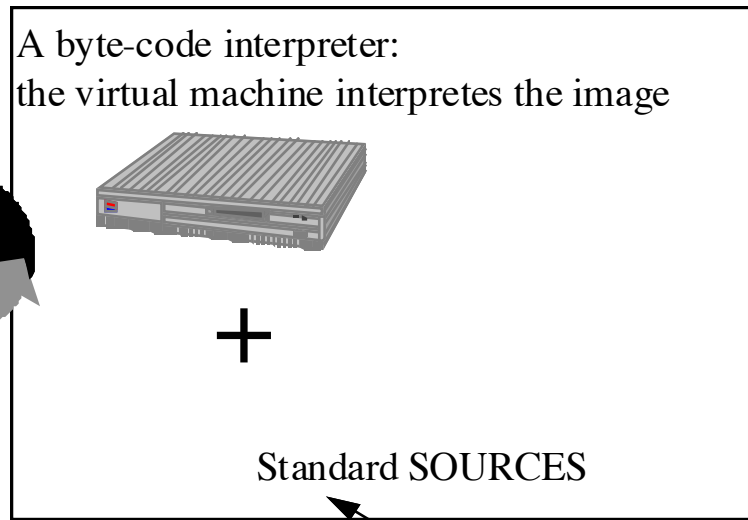
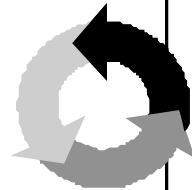
```
accept: aPacket  
  (aPacket isAddressedTo: self)  
    ifTrue:[  
      Transcript show:  
        'A packet is accepted by the Workstation ',  
        self name asString ]  
    ifFalse: [super accept: aPacket]
```

# 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



Shared by everybody

IMAGE2.IM  
IMAGE2.CHA

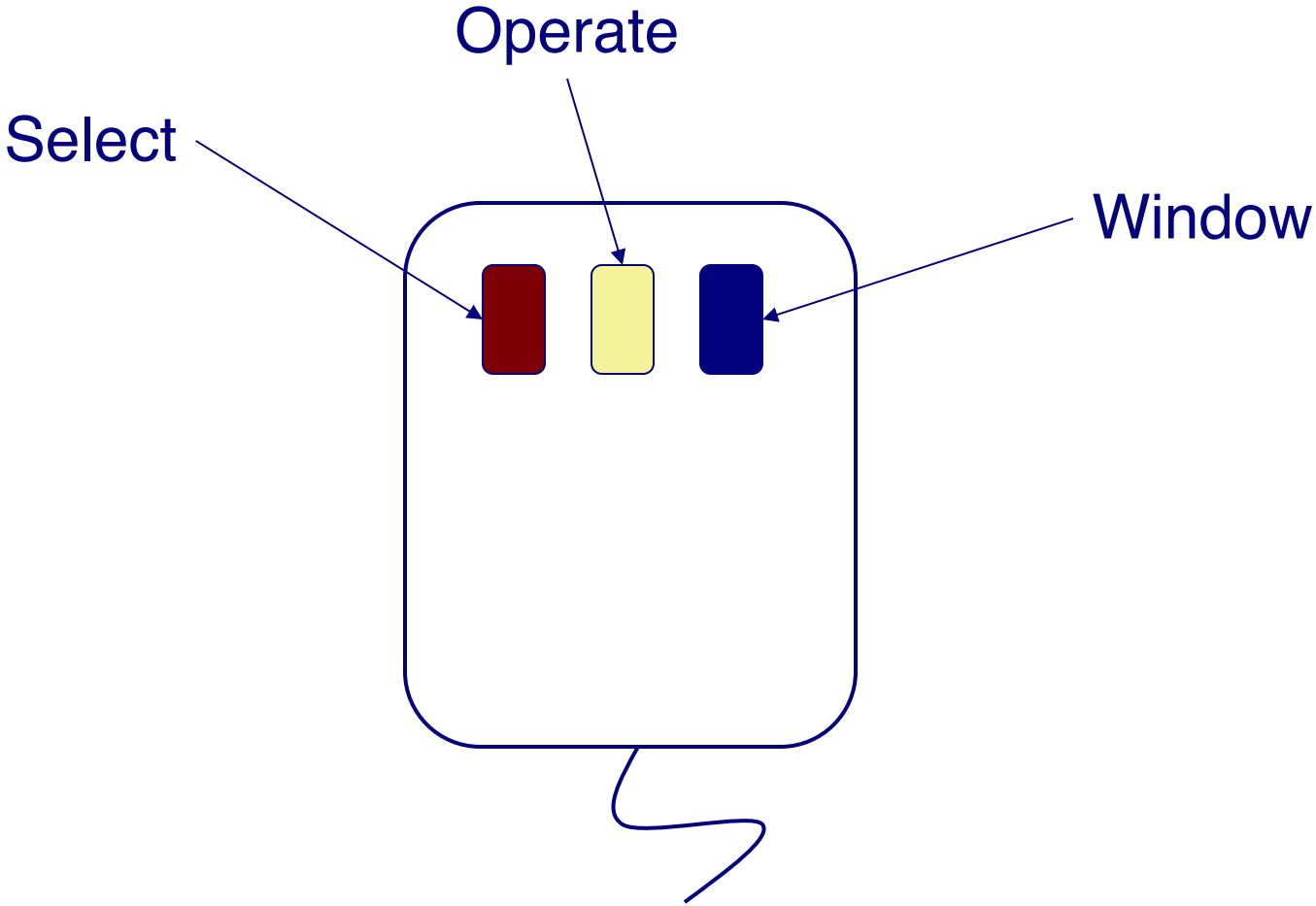
One per user

- > Image = bytecodes
- > Sources and changes = code (text)

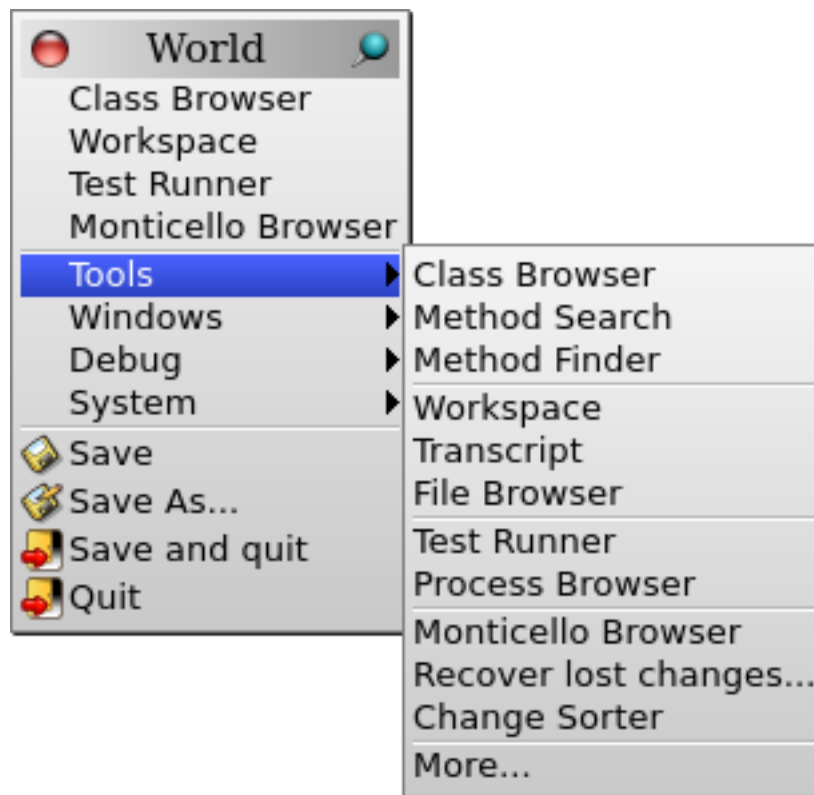
# Smalltalk Run-Time Architecture

- > 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.

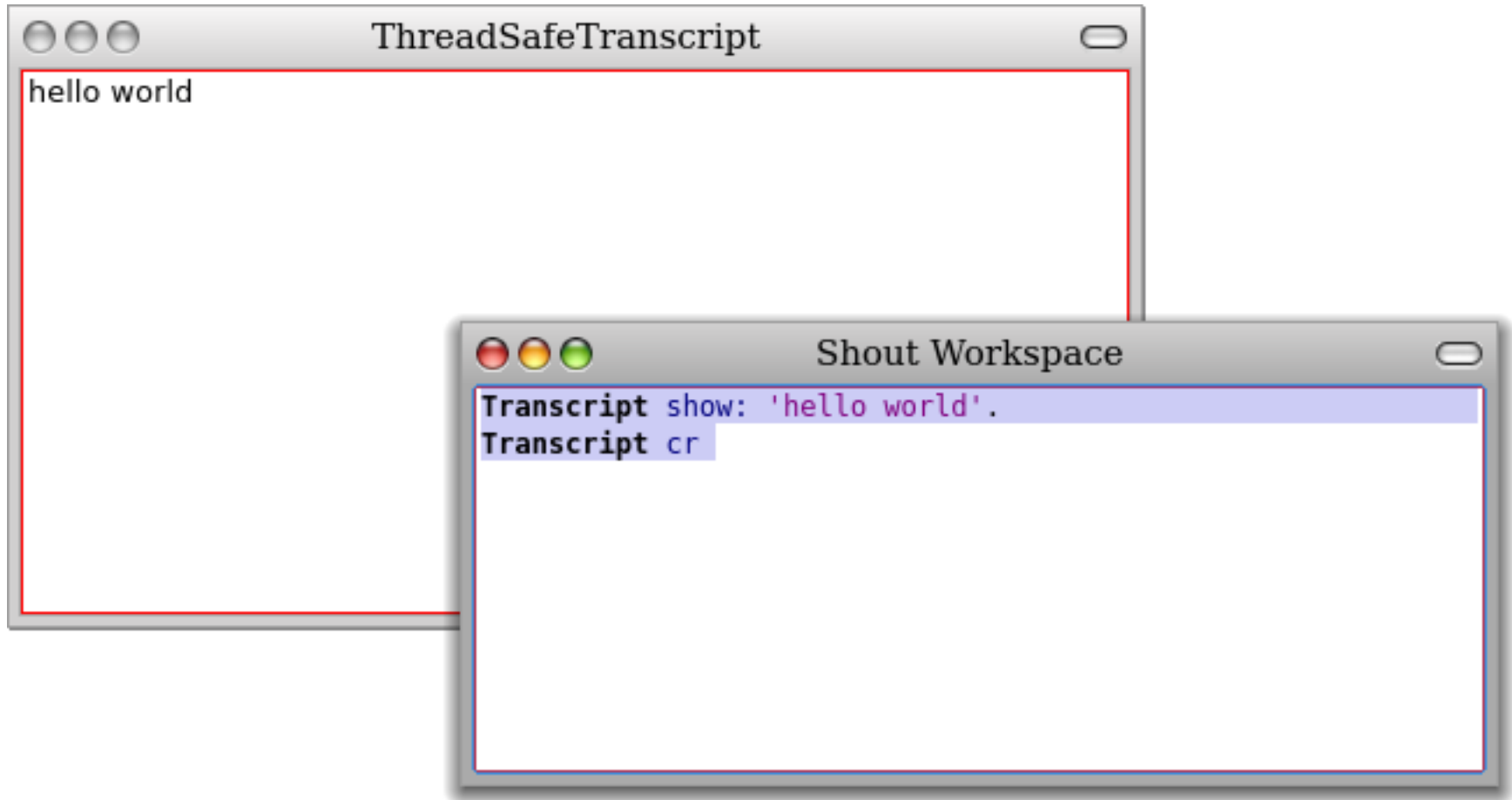
# Mouse Semantics



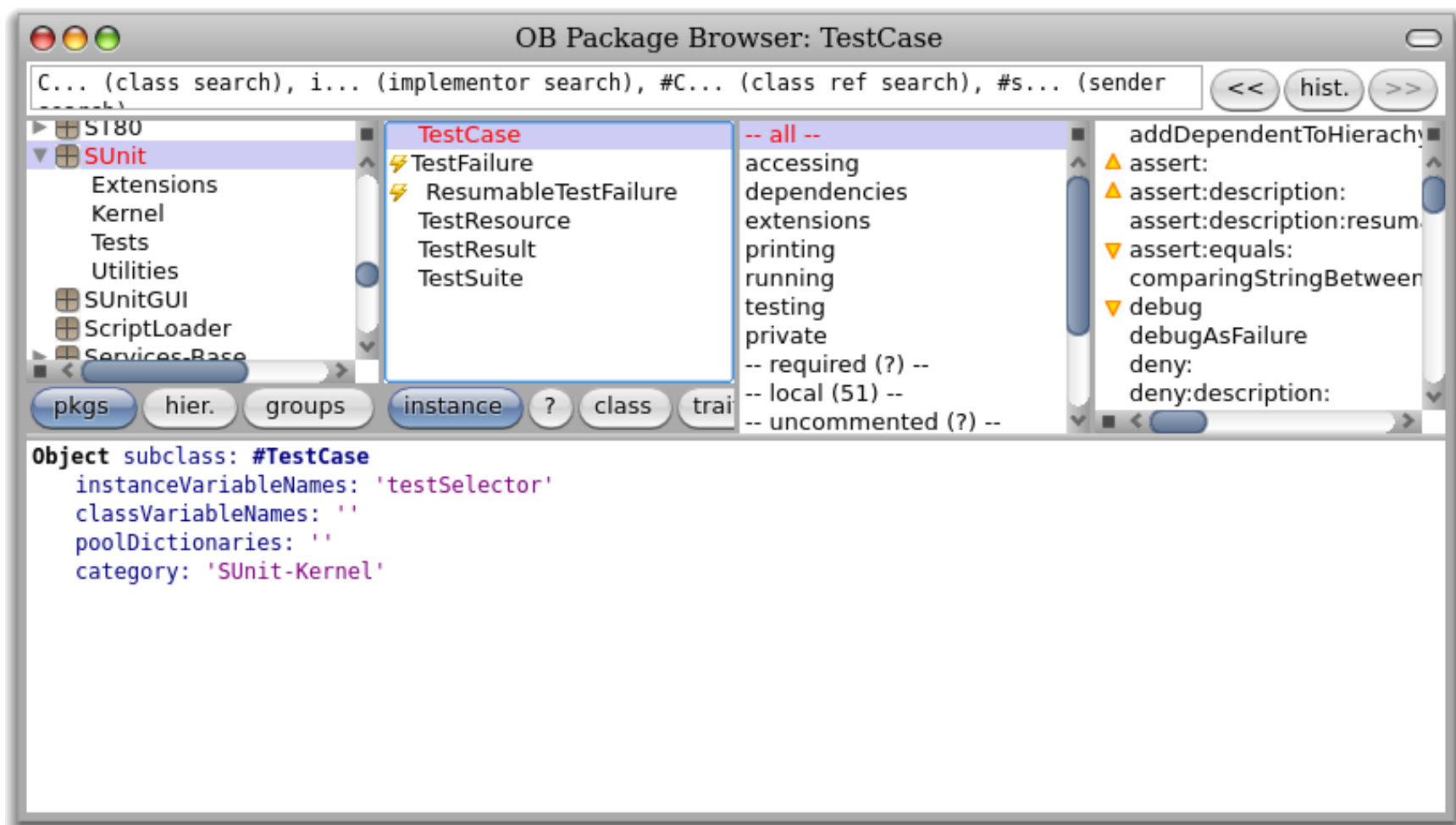
# World Menu



# “Hello World”

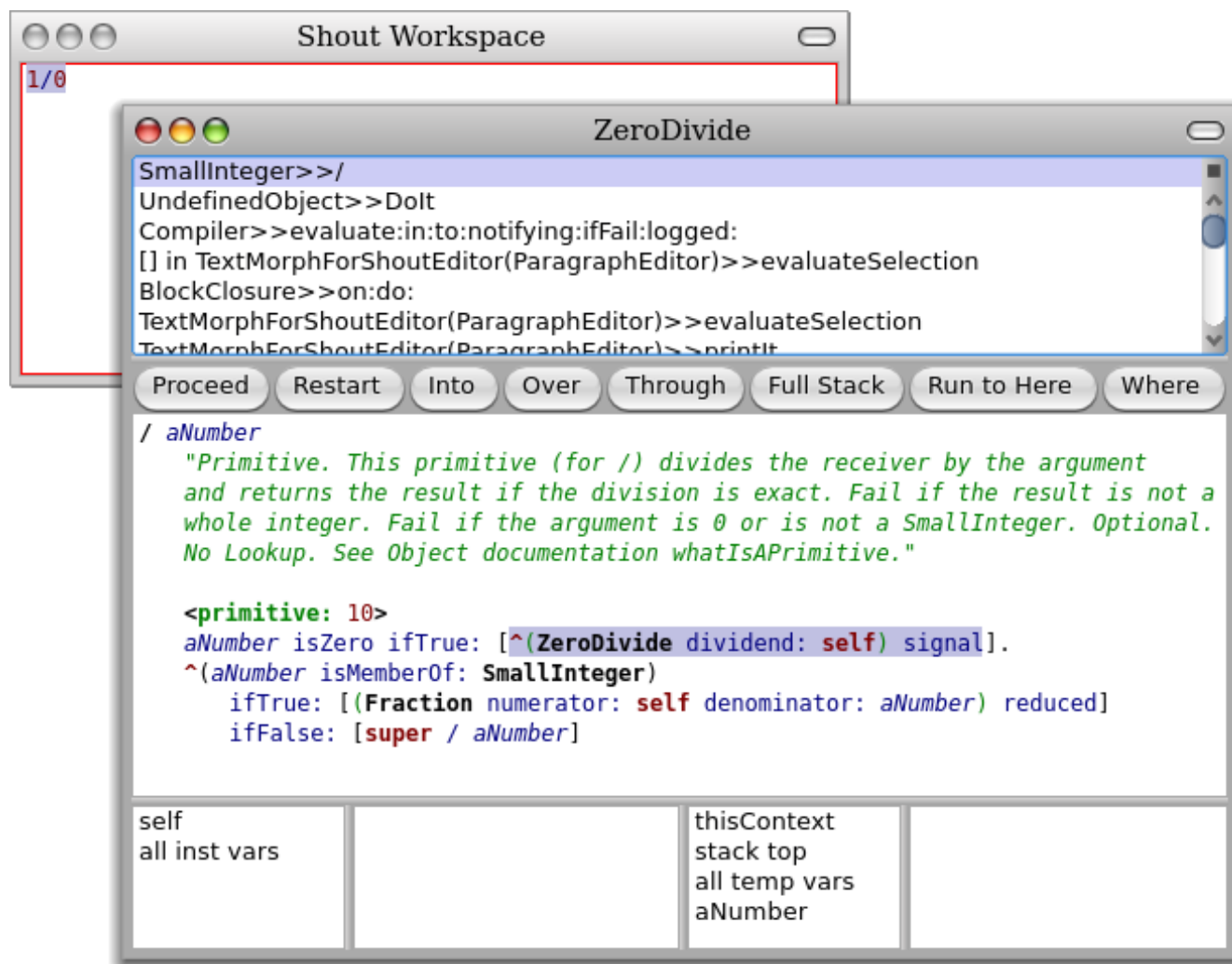


# The Smalltalk Browser

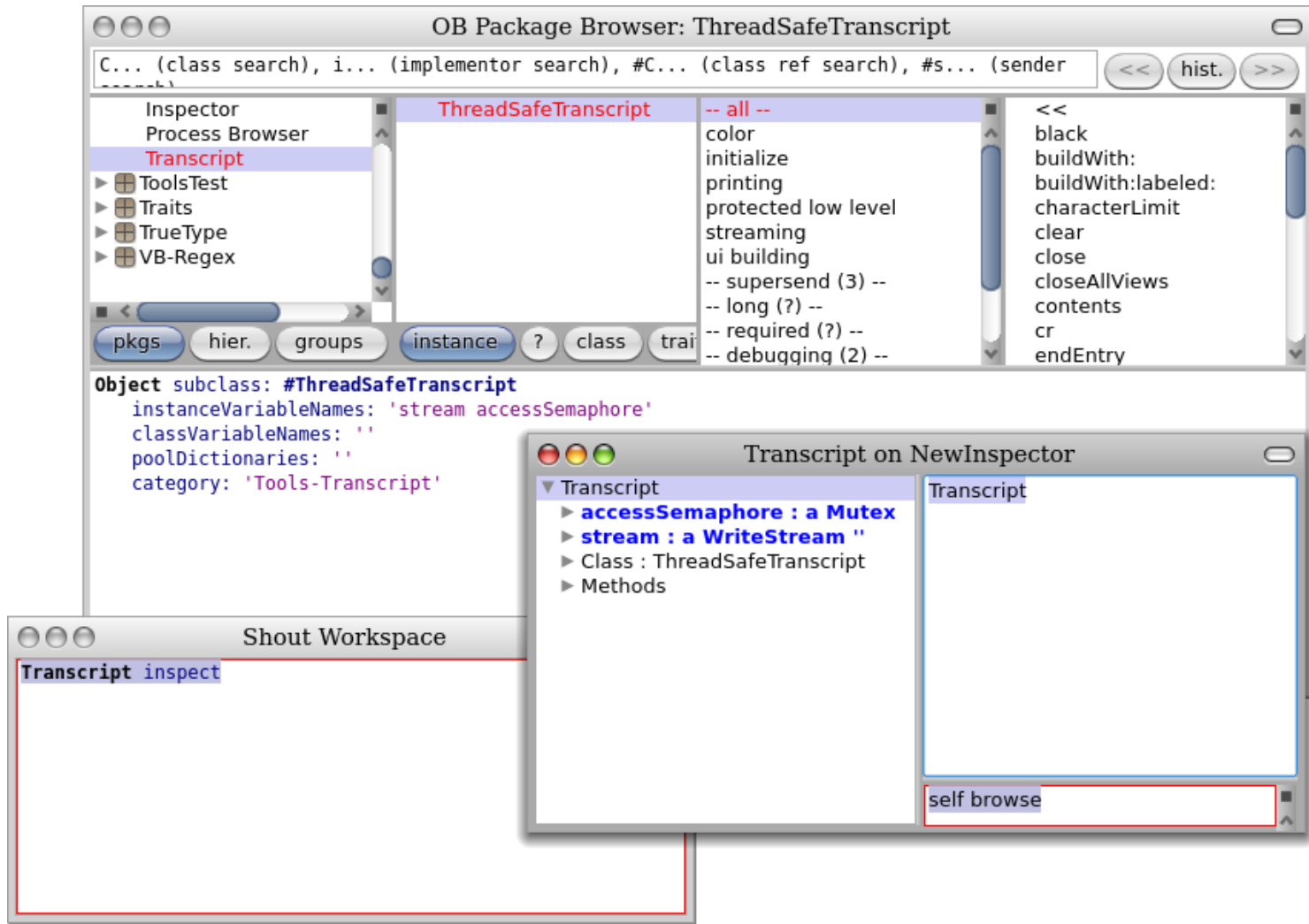




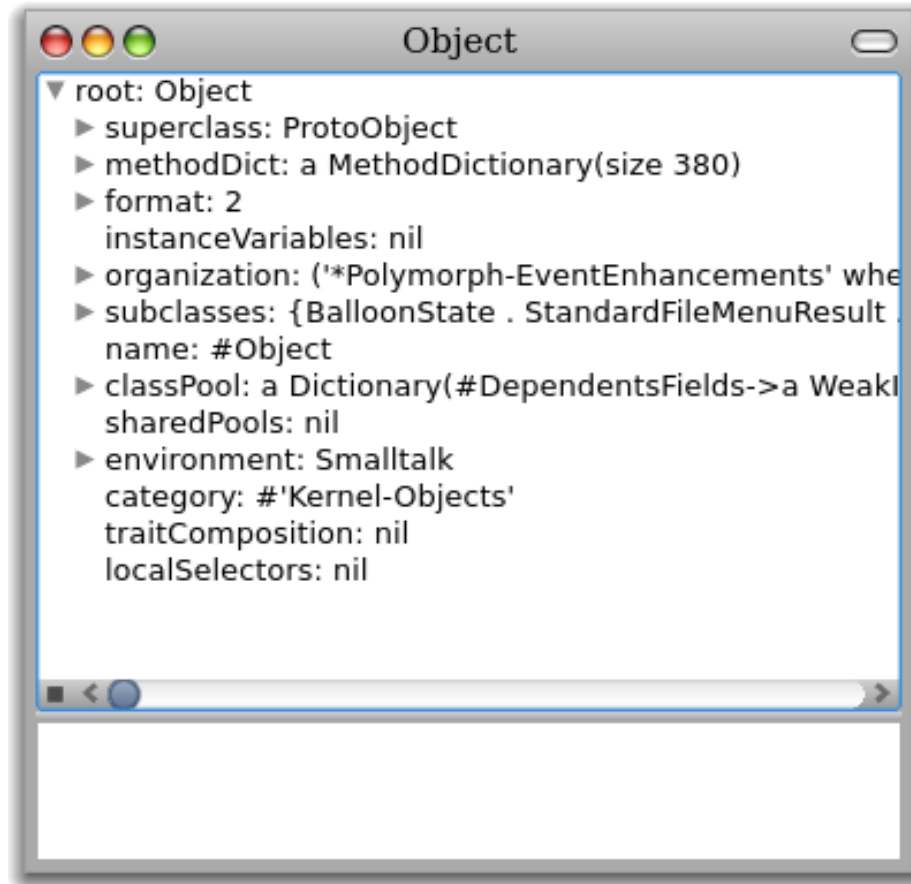
# The Debugger



# The Inspector



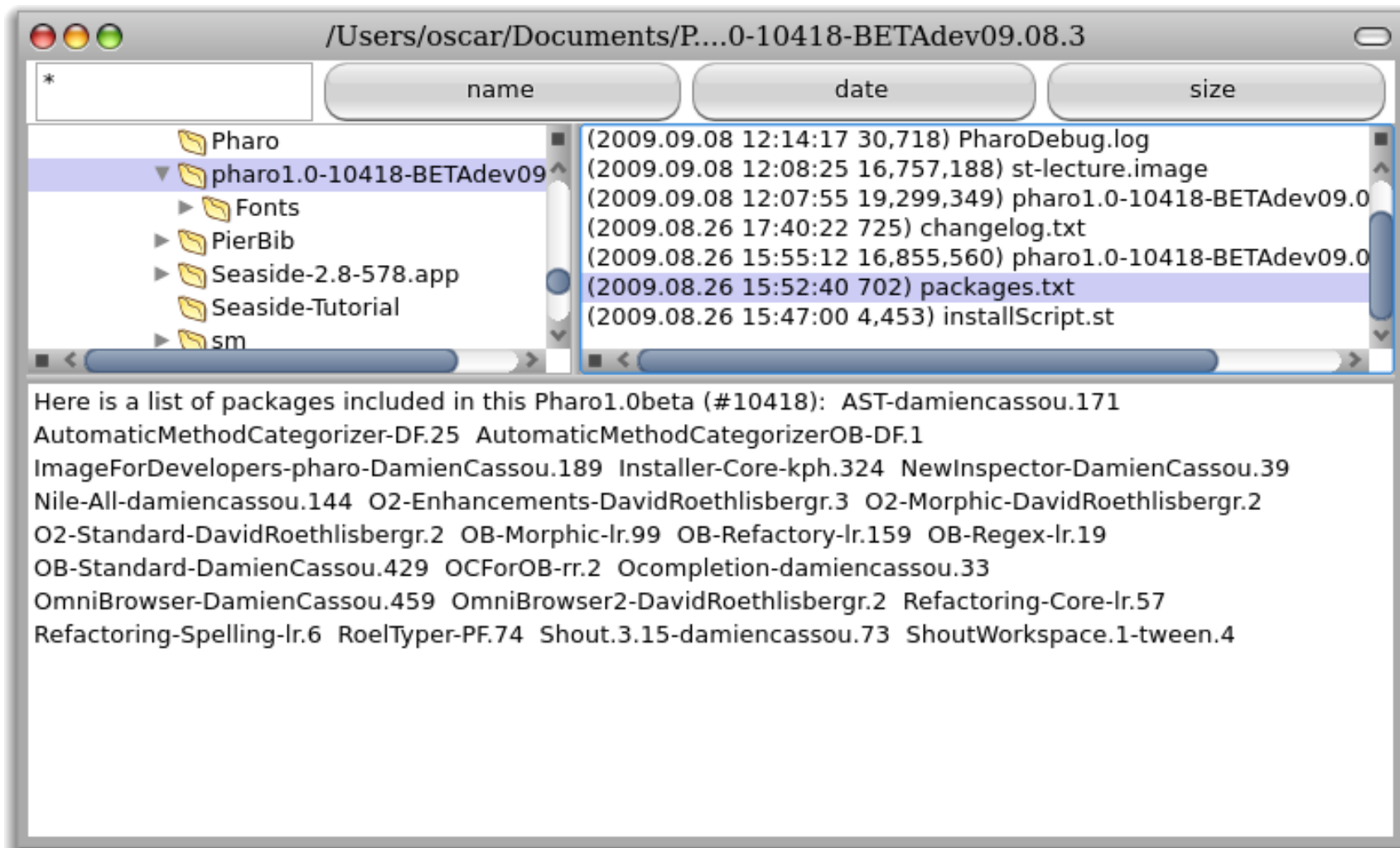
# The Explorer



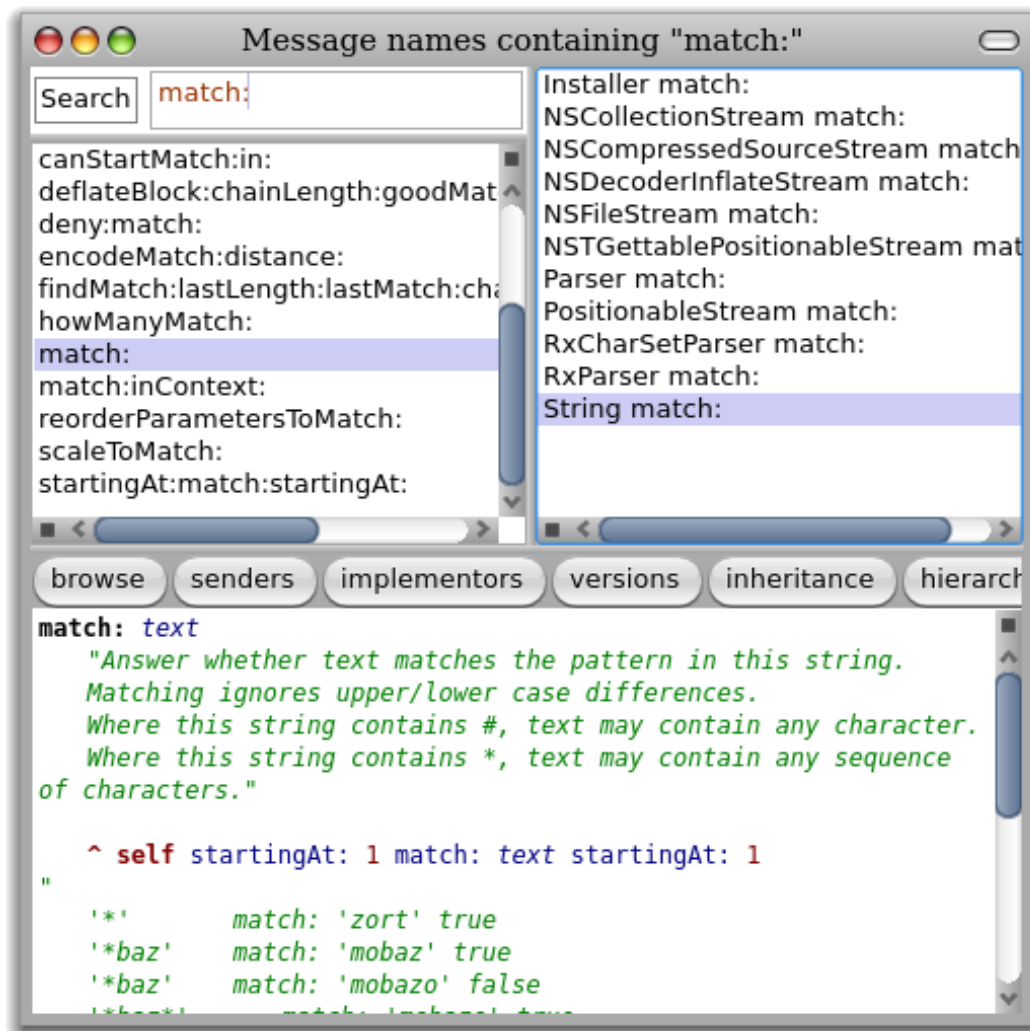
# Other Tools

- > 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*

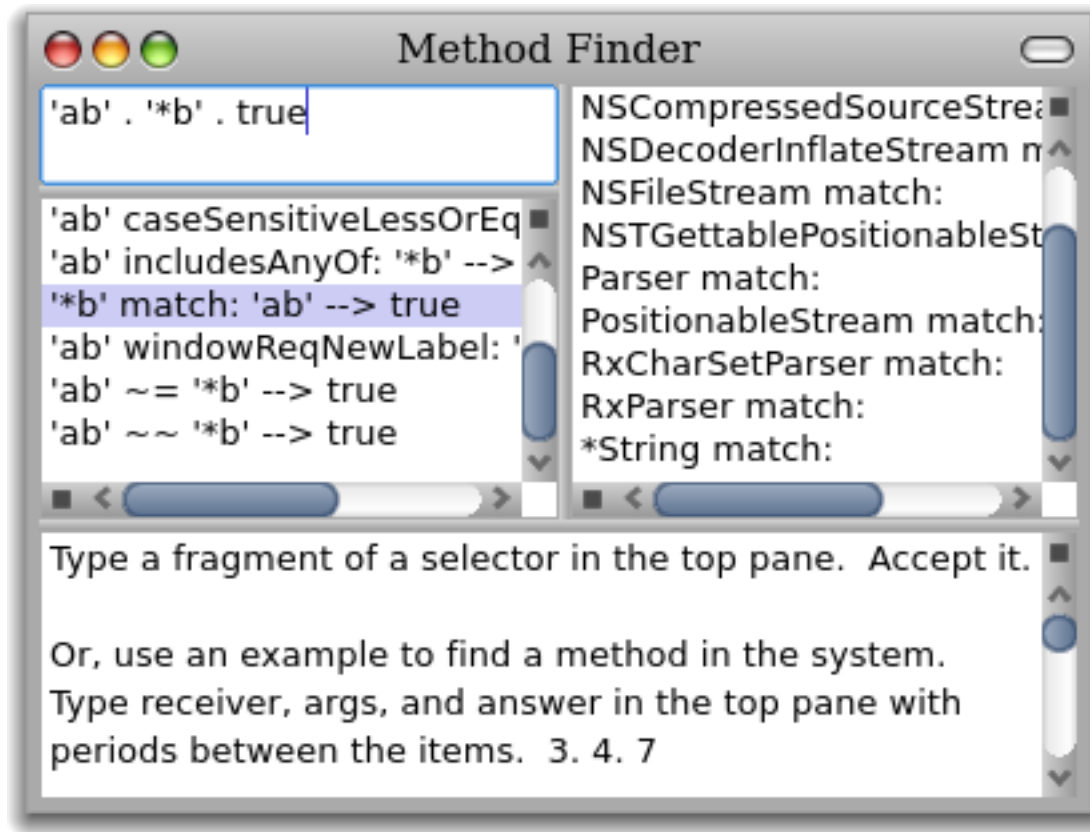
# File Browser



# Message Name Finder



# Method Finder



# Methods in ChangeSets & Versions

Changes go to "Unnamed"

Money  
ImageForDevelopers-pha  
AutomaticMethodCategor  
AutomaticMethodCategor  
Nile-Base-cyrille\_delauna  
Ocompletion-damiencass

Money  
Money class  
TestMoney

setUp  
testAdd  
testEquals

setUp  
chf2 := Money currency: 'C  
chf8 := Money new currency  
chf10 := Money new currenc  
10.

Money.2.cs log

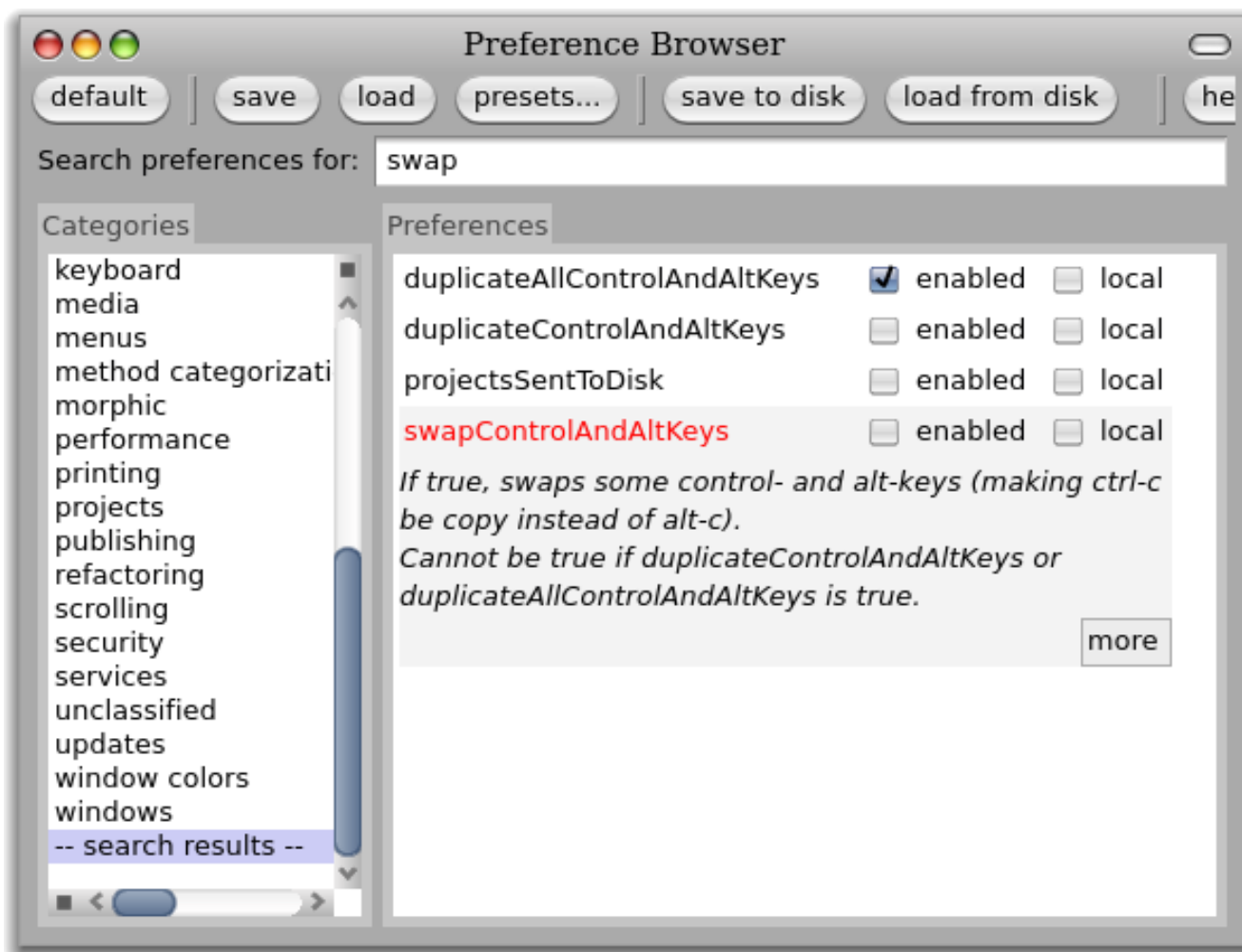
method: Money amount;; on 7/2/2007 13:18  
method: Money currency;; on 7/2/2007 13:17  
method: Money currency;; on 7/2/2007 13:18  
method: Money class currency:amount;; on 7/2/2007 13:23  
method: Number chf; on 7/2/2007 13:30  
method: TestMoney setUp; on 7/2/2007 13:28  
method: TestMoney testAdd; on 7/2/2007 13:25  
method: TestMoney testEquals; on 7/2/2007 13:17  
preamble: Number reorganize  
do it: ('arithmetic' \* + - //...onZero)/(\*Money' chf)/

select all    deselect all    select conflicts    file in selections    diffs    prettyDiffs

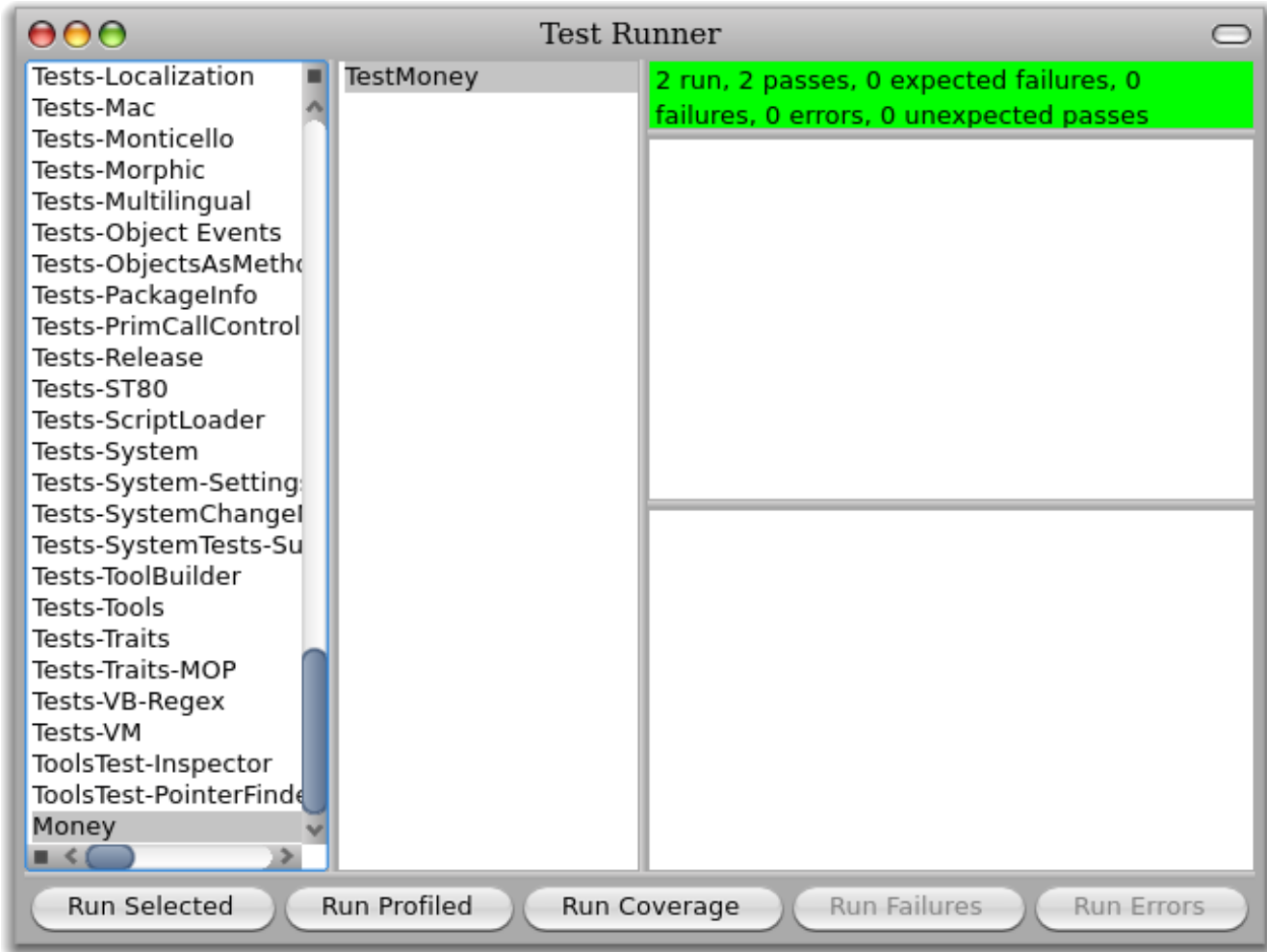
```
setUp
  chf2 := 2 chf.
  chf8 := 8 chf.
  chf10 := 10 chf.
  chf2 := Money currency: 'CHF' amount: 2.
  chf8 := Money new currency: 'CHF'; amount: 8.
  chf10 := Money new currency: 'CHF'; amount: 10.
```










# Preferences



# SUnit



# *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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