CPS506 - Comparative Programming Languages

Smalltalk

Dr. Dave Mason
Department of Computer Science
Ryerson University

Smalltalk

In this section we will:

- Look at Smalltalk history
- Explore Smalltalk Syntax and Pharo

History

- Alan Kay at Xerox PARC, with Adele Goldberg and Dan Ingalls, along with Ted Kaehler, Larry Tesler
- wanted to build Dynabook
- Sketchpad, LOGO, Lisp, Simula
- Smalltalk-71
- Smalltalk-72 on the ALTO
- Smalltalk-76
- Smalltalk-80 - standard to today
- extensions, but forward compatible

Overview

- the prototypical class-based object-oriented language
- minimal - no reserved words
- control structures as methods
- typically high-performance byte-code interpreter

Paradigm

- pure Object-Oriented
- class based
- simple, metacircular, reflective

Syntax

```
exampleWithNumber: x
    | y |
    true & false not & (nil isNil) ifFalse: [self halt].
    y := self size + super size.
    #($a #a 'a' "a" 1 1.0)
        do: [ :each |
            Transcript show: each class name;
                       show: ' '].
    ^x < y
```

Syntax Rules

1. literals
   - numbers: `-17`
     `3.141592`
     `2r101`
     `16r2c4f`
   - characters: `$a`
     `$(`
   - strings: `'this isn''t "hard"!'`
   - symbols: `#asymbol #'a symbol'`
     `#aSymbol:`
   - arrays:
     `#( abc nil #nil 3 ** 'string'  (a subarray) $! )`
   - blocks: `[ 3 ] [ : arg | arg-4 ]`
2. variables
   - upper/lower case, digits; case sensitive; camel-case
   - arguments to methods and blocks
   - temporaries `| a b |` at beginning of methods and blocks
   - instance variables
   - global variables - includes class names

No reserved words; only `self super nil true false`

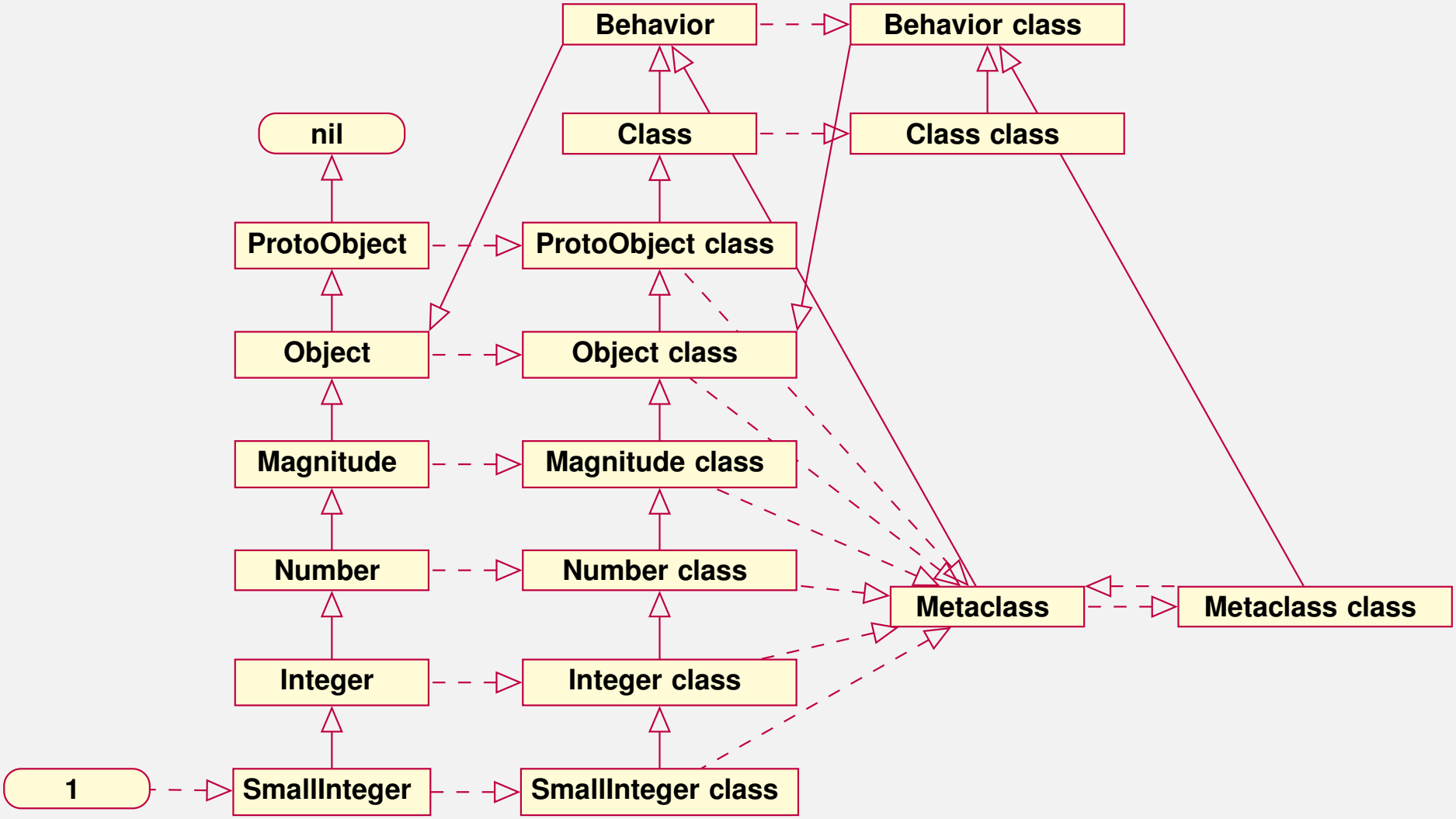
Semantics

- everything is an object
- only 3 operations
  - assignment
  - message send
  - return result
- class-based method tables
- intrinsic rich meta-environment

Pharo

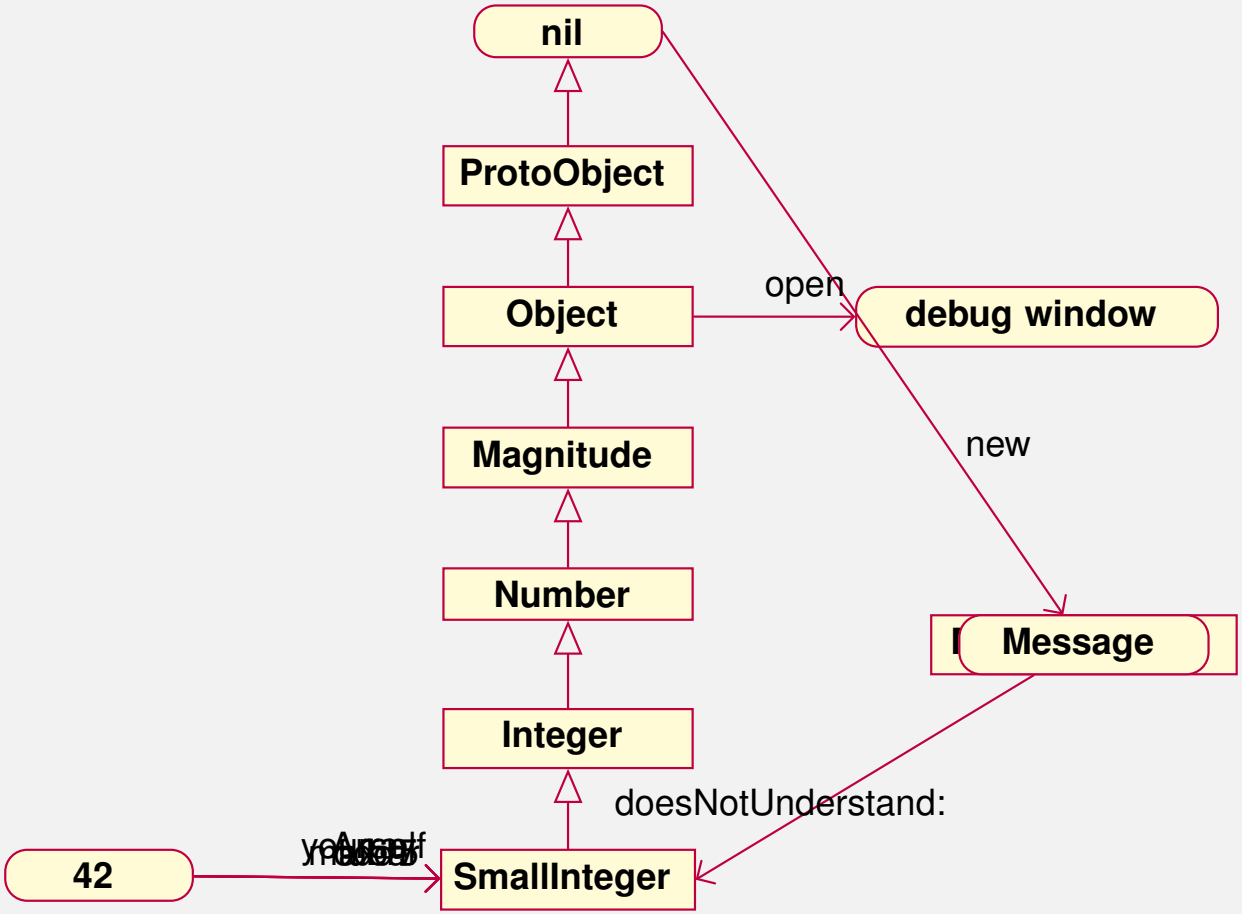
- Squeak version of Smalltalk built from scratch at Apple, Walt Disney Imagineering by Dan Ingalls and Alan Kay
- built to explore Dynabook ideas
- 2 significant forks:
  - Pharo for “business”
  - Cuis for teaching
- Currently Pharo 10 pharo.org

Class Structure



1 1 class 1 class superclass 1 class superclass superclass superclass superclass superclass superclass 1 class class 1 class class superclass = 1 class superclass class 1 class class superclass superclass superclass superclass superclass 1 class class superclass superclass superclass

Method Dispatch



`42 42 odd 42 max: 5 42 yourself 42 fubar 42 Array` *(after defining a DNU for SmallInteger)*

Method Dispatch...

- many special cases
- “ implementing a language like Smalltalk efficiently requires the implementor to cheat... but that’s okay as long as you don’t get caught” - Peter Deutsch (creater of JITs and many other language optimizations
- `ifTrue:ifFalse:` `do:` `whileTrue:`, etc.
- primitives
- hashed dispatch

Types

- hardware level - instructions act on register of bits
- statically typed
  - types determined and instructions chosen at compile time
  - **variables** and **expressions** have types
  - less flexible, sometimes much less
  - safety variable
- dynamically typed
  - types determined and instructions chosen at run time
  - **values** have types
  - safety assured

Type determination

- values tagged - size of a register
- fallback is to heap-allocated object
- simplest tagging is just differentiating `SmallInteger`
- description for AST Smalltalk - alternate dispatch
- documentation for GNU Smalltalk
- code for OpenSmalltalk

Pragmatics

- garbage-collected
- usually image-based development
- best-in-class IDE
- optimized VM (JIT)

Environment and IDE

1. image-based
2. IDE that others aspire to
3. class browser, playground, debugger, inspector, senders, receivers, refactoring, transcript, unit-test runner, code critic, method versions, interruptable
4. even if crashes, changes recoverable

Evaluation

- Simplicity
  - Size of the grammar
  - complexity of navigating modules/classes
- Orthogonality
  - number of special syntax forms
  - number of special datatypes
- Extensibility
  - functional
  - syntactically
  - defining literals
  - overloading