Refactoring and Reflection

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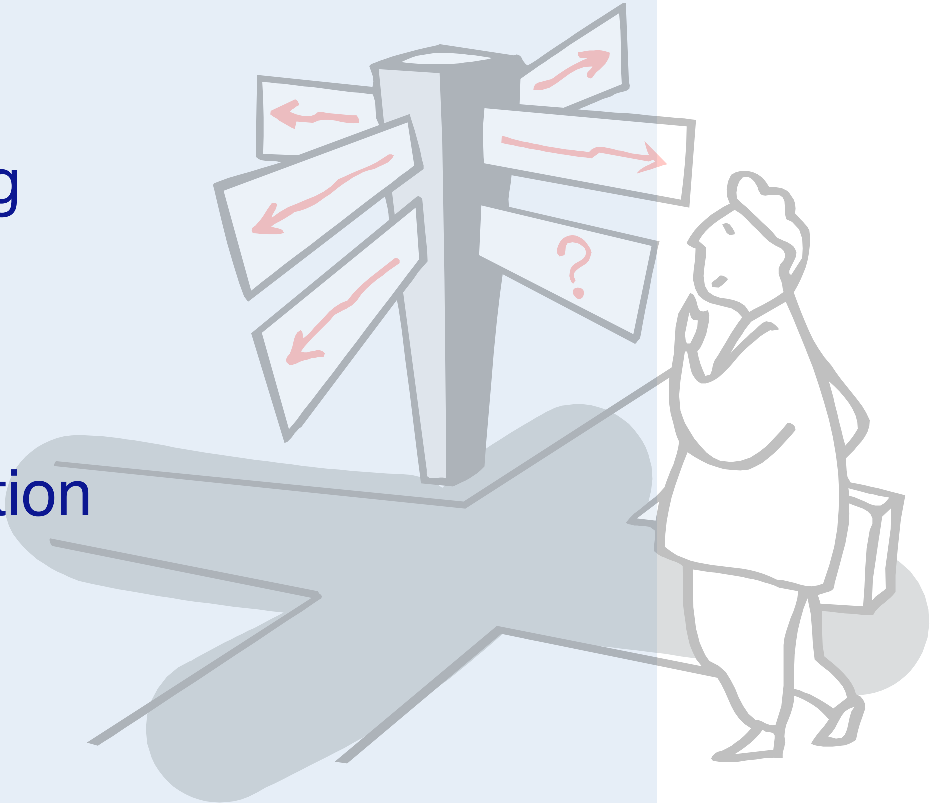
Roadmap

> First lecture: Refactoring
  - Squeak as an example

> Second Lecture: Reflection
  - About current research



Part I: Refactoring

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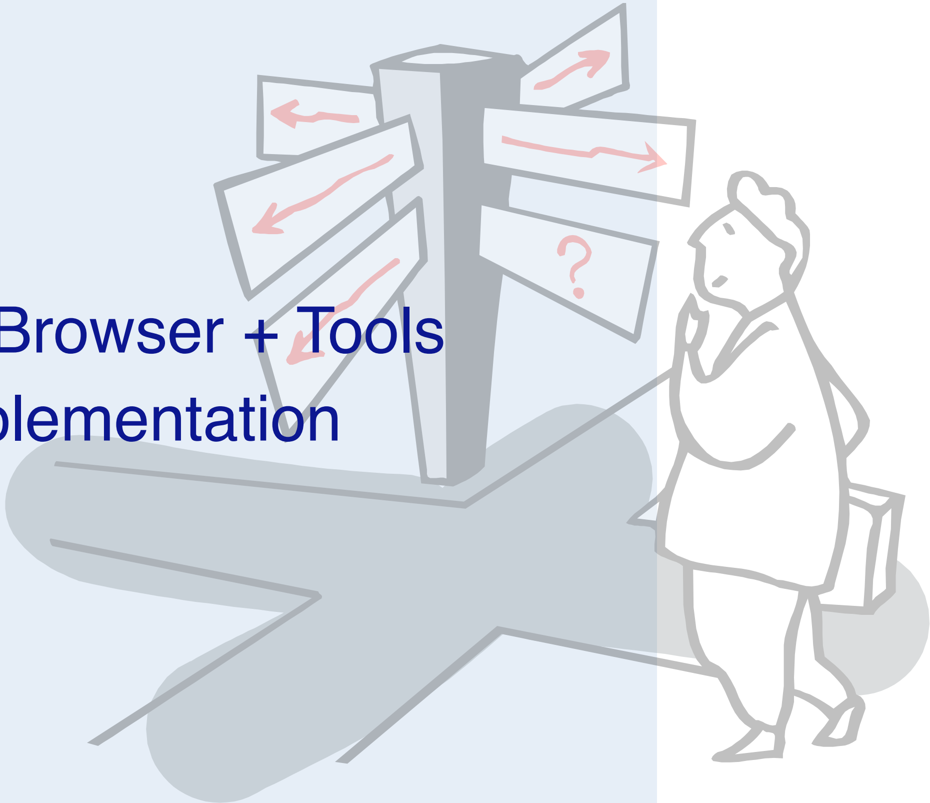
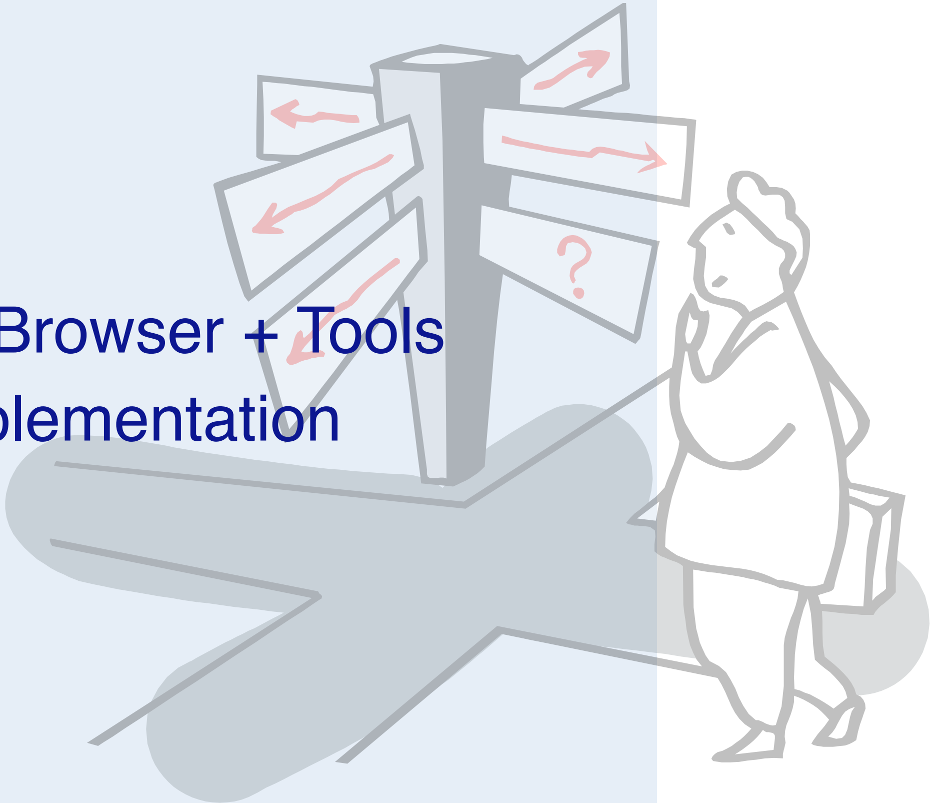
Overview



- > Refactoring: Basics
- > Refactoring in Squeak: Browser + Tools
- > Refactoring Engine: Implementation
- > Discussion: Reflection?

Roadmap

> **Refactoring: Basics**
> Refactoring in Squeak: Browser + Tools
> Refactoring Engine: Implementation
> Discussion: Reflection?



What is Refactoring?

> The process of *changing a software system* in such a way that it *does not alter the external behaviour* of the code, yet *improves its internal structure*.

— Fowler, et al., Refactoring, 1999.

Typical Refactorings

Class	Method	Attribute
add (sub)class to hierarchy	add method to class	add variable to class
rename class	rename method	rename variable
remove class	remove method	remove variable
	push method down	push variable down
	push method up	pull variable up
	add parameter to method	create accessors
	move method to component	abstract variable
	extract code in new method	

Why Refactor?

"Grow, don't build software"

— Fred Brooks

> The reality:

- — Extremely difficult to get the design "right" the first time
- — Hard to fully understand the problem domain
- — Hard to understand user requirements, even if the user does!
- — Hard to know how the system will evolve in five years
- — Original design is often inadequate
- — System becomes brittle over time, and more difficult to change

> Refactoring helps you to

- — Manipulate code in a safe environment (behavior preserving)
- — Recreate a situation where evolution is possible
- — Understand existing code

Rename Method — manual steps

> Do it yourself approach:
- Check that no method with the new name already exists in any subclass or superclass.
- Browse all the implementers (method definitions)
- Browse all the senders (method invocations)
- Edit and rename all implementers
- Edit and rename all senders
- Remove all implementers
- Test

> Automated refactoring is better !

Rename Method

- Rename Method (method, new name)
- Preconditions
  - No method with the new name already exists in any subclass or superclass.
  - No methods with same signature as method outside the inheritance hierarchy of method
- PostConditions
  - method has new name
  - relevant methods in the inheritance hierarchy have new name
  - invocations of changed method are updated to new name
- Other Considerations
  - Typed/Dynamically Typed Languages => Scope of the renaming

Refactoring and Metaprograming

- Automated Refactoring is metaprograming
  - We use a program to edit programs
- Does not need to use Reflection
  - Pure source-to-source transformation (e.g. Java)
- Uses reflective facilities in Smalltalk
  - But… let’s discuss that at the end

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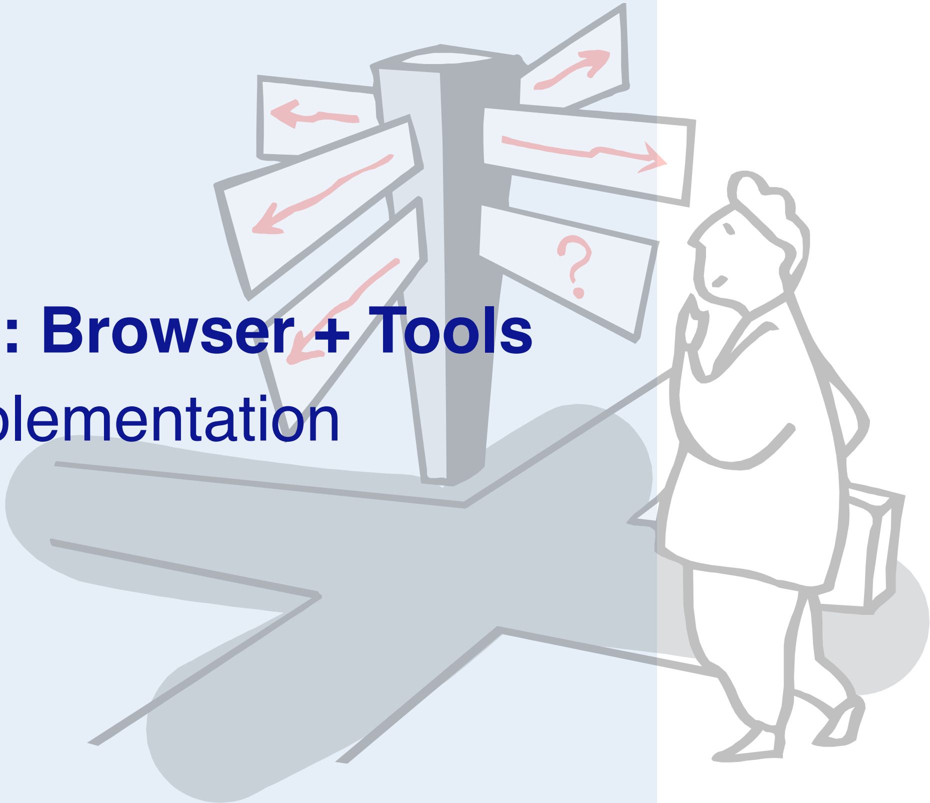
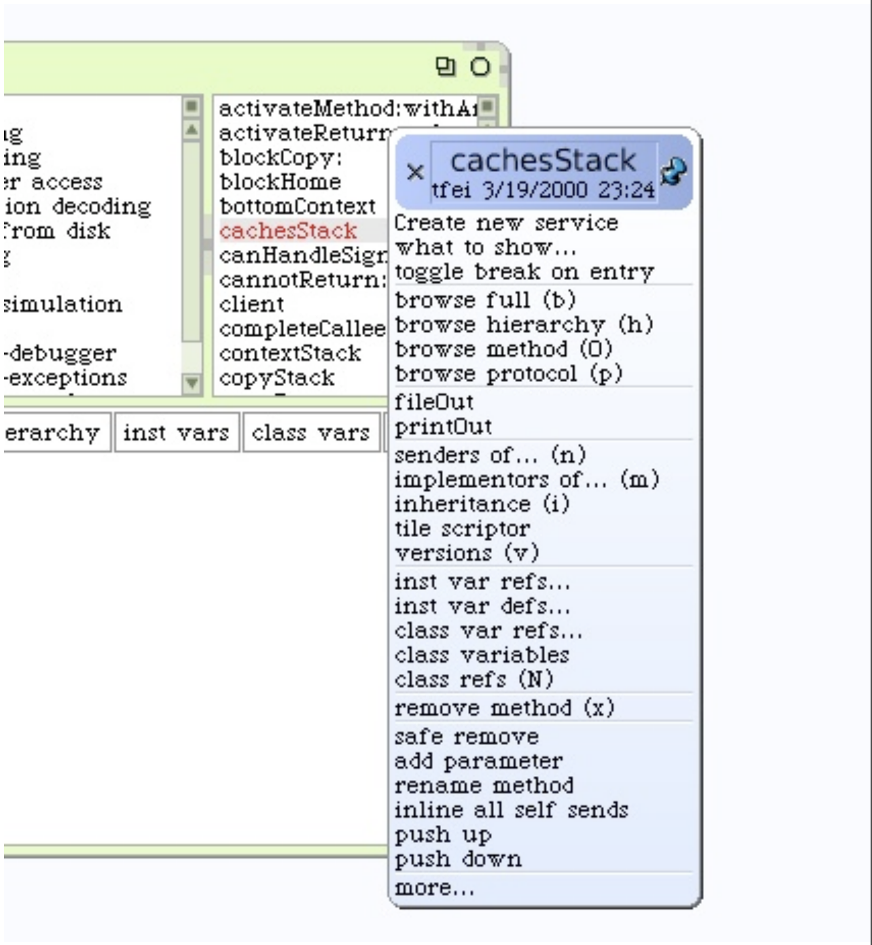


Refactoring in Squeak

- No support in standard IDE
  - Example: Try to rename a method
- Refactoring Browser
  - First Refactoring Browser (for any language)
  - Now over 10 years old
- Installation
  - Get Squeak 3.9 (older version for 3.8, too)
  - Install Package AST
  - Install Package Refactoring Engine

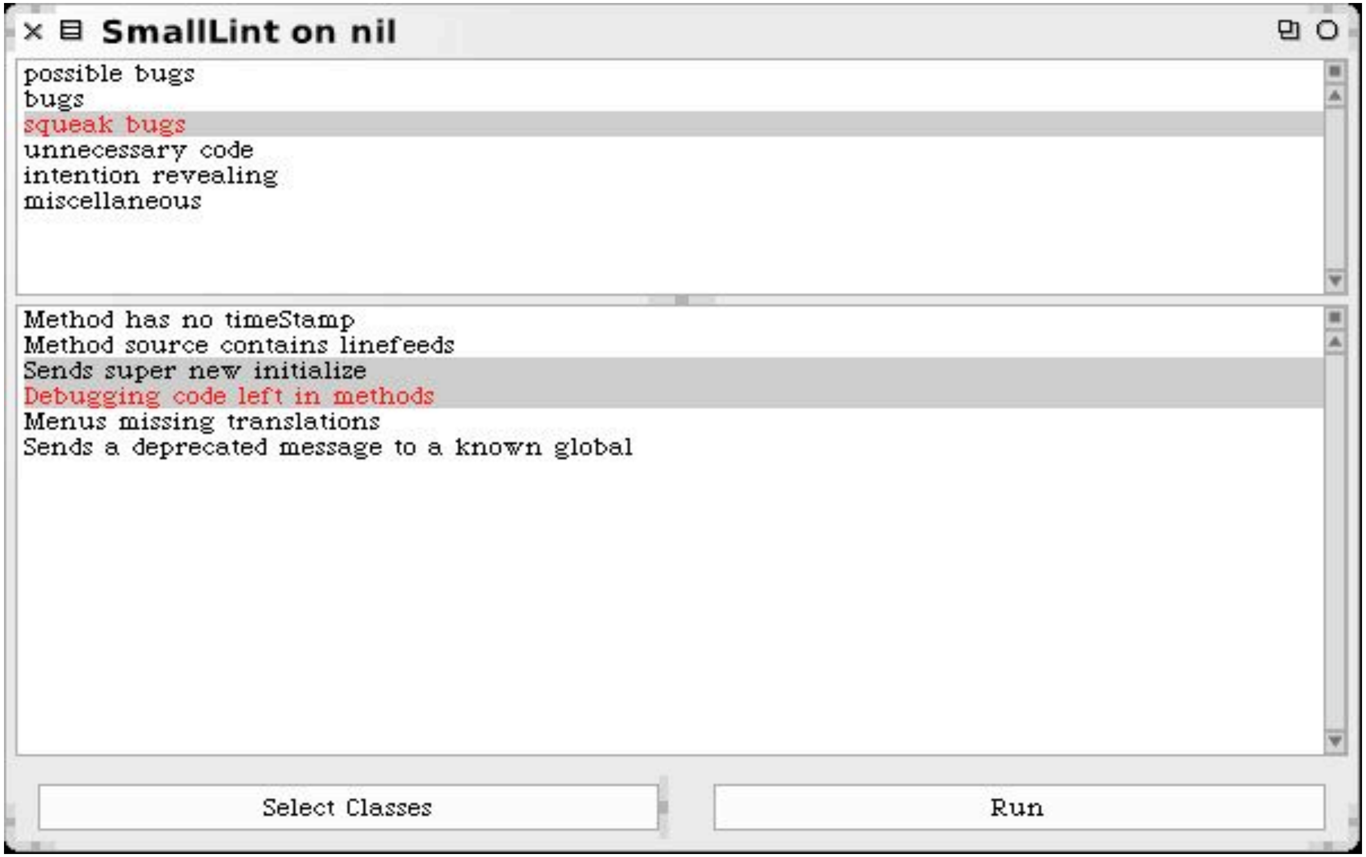
Refactoring Browser

> Browser with menus for e.g
  - rename
  - Push up/down
  - Inlining
  - Add parameter
  - Extraction



SmallLint

- Checks for common mistakes



SmallLint on nil

possible bugs
bugs
squeak bugs
unnecessary code
intention revealing
miscellaneous

Method has no timeStamp
Method source contains linefeeds
Sends super new initialize
Debugging code left in methods
Menus missing translations
Sends a deprecated message to a known global

SmallLint Checks

- Possible Bugs
  - Variable read before written
  - Defines #= but not #hash
  - Modifies Collection while iterating over it

- Bugs
  - Uses True/False instead of true/false
  - Variable used but not defined
- Squeak Bugs
- Unnecessary Code
- Intention Revealing

SmallLint

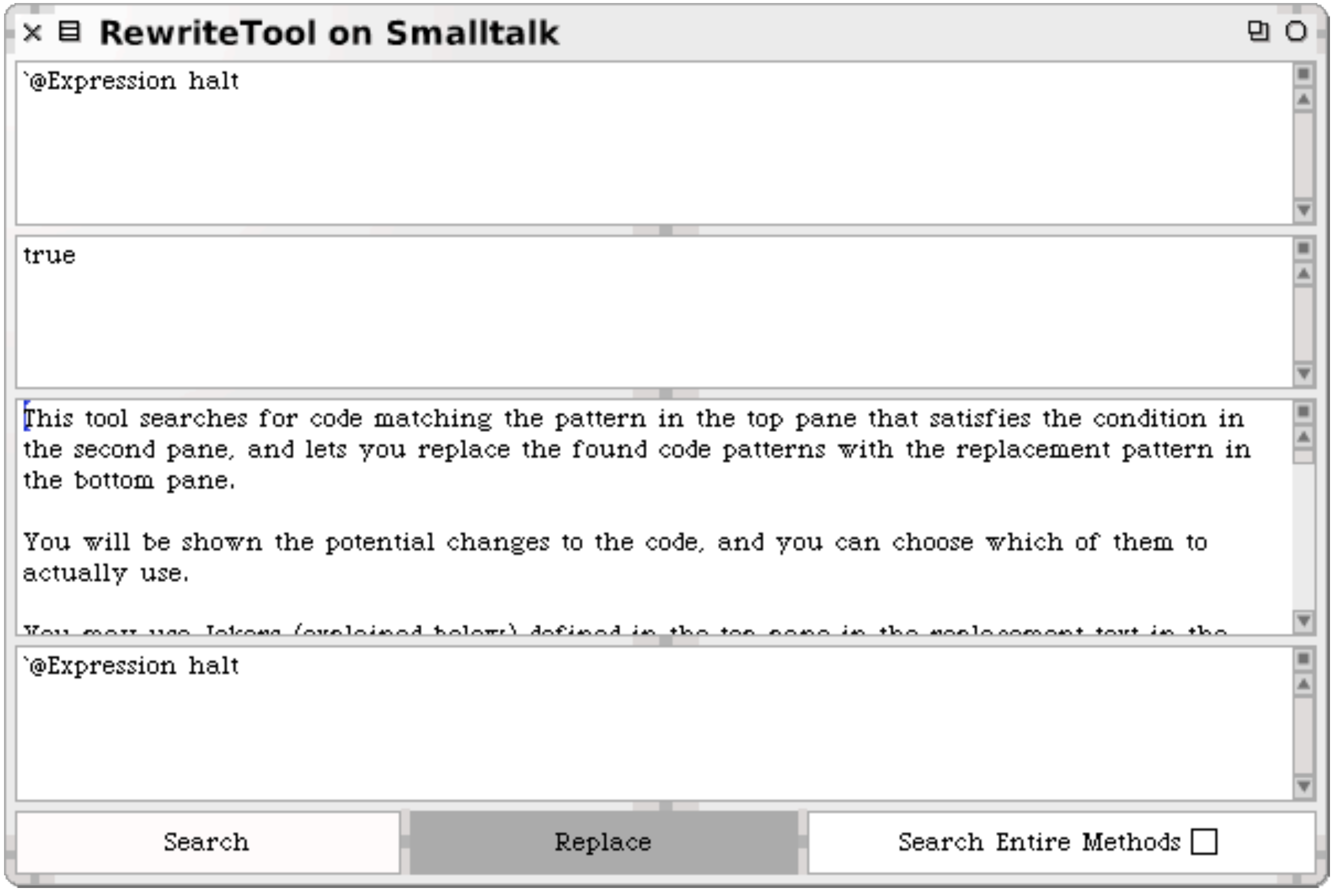
- Very useful!
- Especially valuable for beginners

- Has been integrated with SUnit
  - Call SmallLint automatically as a test

- Tag methods where SmallLint is wrong
  - Uses Squeak 3.9 Method Pragmas

RewriteTool

- Pattern driven automatic editor



```
`@Expression halt
```

```
true
```

This tool searches for code matching the pattern in the top pane that satisfies the condition in the second pane, and lets you replace the found code patterns with the replacement pattern in the bottom pane.

You will be shown the potential changes to the code, and you can choose which of them to actually use.

You may use Jokers (explained below) defined in the top pane in the replacement text in the

```
`@Expression halt
```

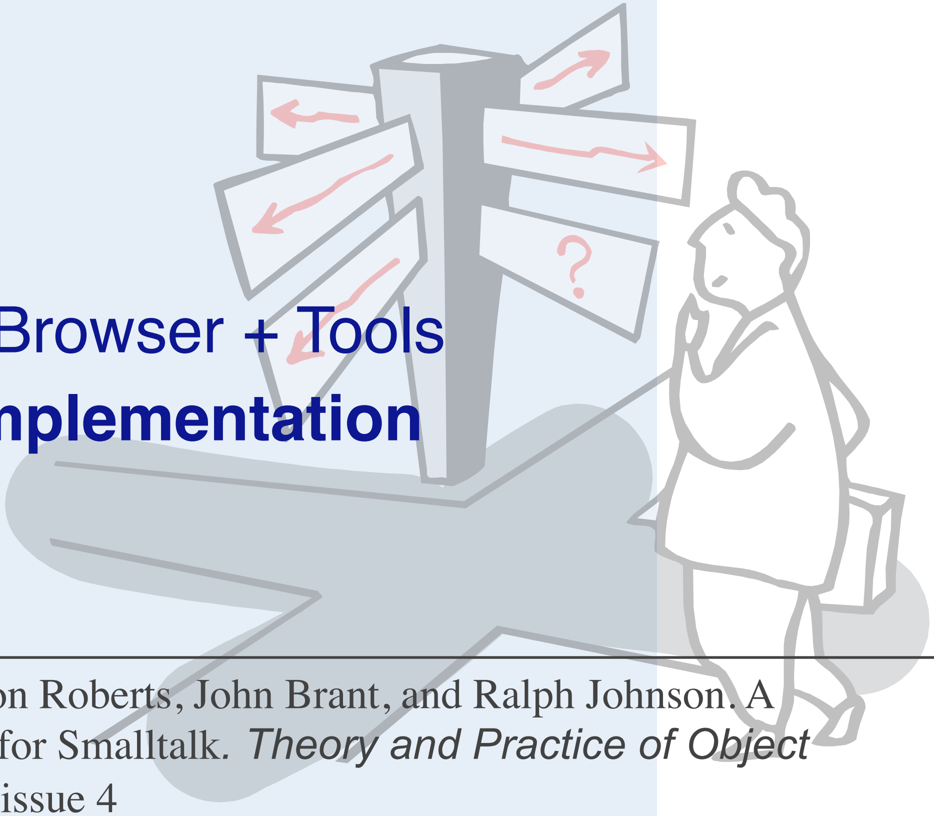
RewriteTool

- Access to full power of Refactoring Engine

- Custom refactorings:
  - generic rewrites that the RB does not currently provide
  - bulk transformations: your project needs to change a project-specific pattern to a new form
  - changing layers: e.g. build a new DB layer, find and change 17,000 references to old layer
  - migrations: e.g. between Smalltalk dialects

- Powerful but not trivial to use
- Examples: Later

Roadmap

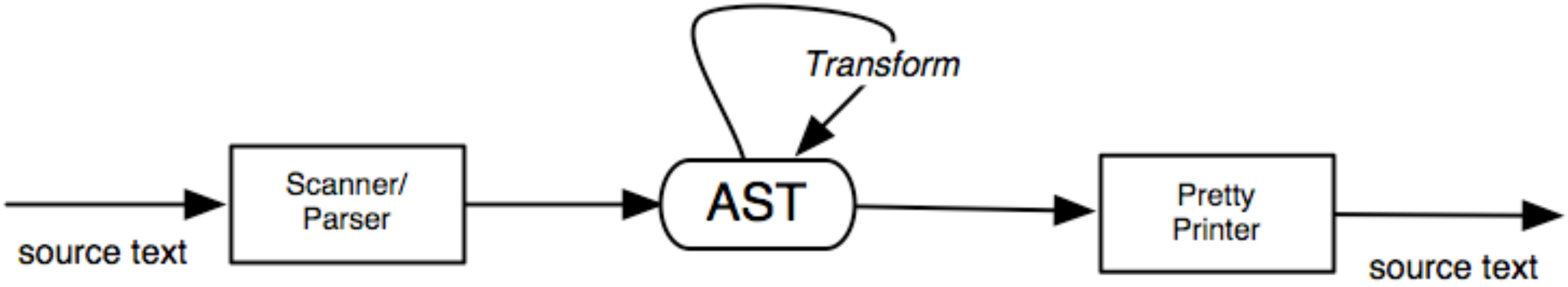


> Refactoring: Basics
> Refactoring in Squeak: Browser + Tools
> **Refactoring Engine: Implementation**
> Discussion: Reflection?

[Main Source] Don Roberts, John Brant, and Ralph Johnson. A Refactoring Tool for Smalltalk. *Theory and Practice of Object Systems*, vol. 3, issue 4

Implementation Overview

- Goal: Transformation on the Source
- Idea: Transform into a higher level tree representation



The RB Abstract Syntax Tree

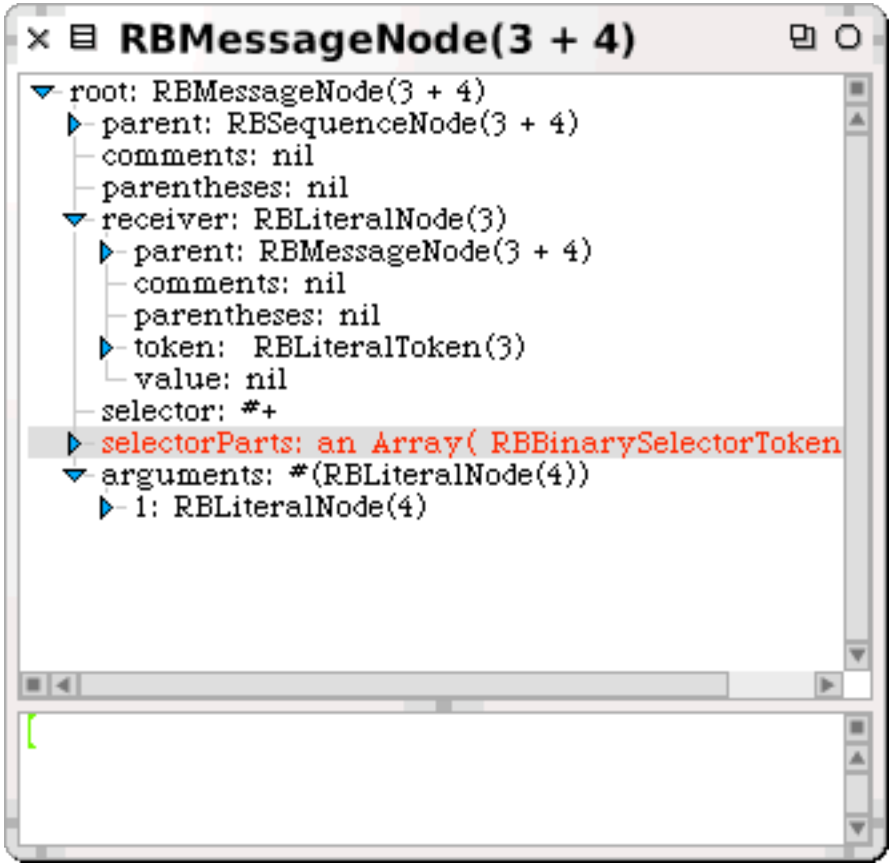
- AST: Abstract Syntax Tree
  - Encodes the Syntax as a Tree
  - Features:
    - *Visitors*
    - *Backward pointers in ParseNodes*
    - *Encodes formatting*
    - *Transformation (replace/add/delete)*
    - *Pattern-directed TreeRewriter*
    - *PrettyPrinter*

```
RBProgramNode
  RBDoItNode
  RBMethodNode
  RBReturnNode
  RBSequenceNode
  RBValueNode
        RBArrayNode
        RBAssignmentNode
        RBBlockNode
        RBCascadeNode
        RBLiteralNode
        RBMessageNode
        RBOptimizedNode
        RBVariableNode
```

A Simple AST

```
RBParser parseExpression: '3+4'
```

explore it



RBMessageNode(3 + 4)

```
root: RBMessageNode(3 + 4)
    parent: RBSequenceNode(3 + 4)
    comments: nil
    parentheses: nil
    receiver: RBLiteralNode(3)
        parent: RBMessageNode(3 + 4)
        comments: nil
        parentheses: nil
        token:  RBLiteralToken(3)
        value: nil
    selector: #+
    selectorParts: an Array( RBBinarySelectorToken
    arguments: #(RBLiteralNode(4))
        1: RBLiteralNode(4)
```

A Simple Visitor

```
RBProgramNodeVisitor new visitNode: tree
```

Does nothing except walk through the tree

More Complete Visitor

```
RBProgramNodeVisitor subclass: #TestVisitor
   instanceVariableNames: 'literals'
   classVariableNames: ''
   poolDictionaries: ''
   category: 'Compiler-AST-Visitors'

TestVisitor>>acceptLiteralNode: aLiteralNode
   literals add: aLiteralNode value.

TestVisitor>>initialize
   literals := Set new.

TestVisitor>>literals
   ^literals
```

```
tree := RBParser parseExpression: '3 + 4'.
(TestVisitor new visitNode: tree) literals
```

```
a Set(3 4)
```

Tree Matcher

- Implementing all Refactorings with visitors
  - Too much work
  - Too low level

- Needed: High level specification of transformations

- Rewrite Engine: Core of Refactoring Engine

- No only useful for Refactoring!

Tree Matcher

- Describe transformation by using patterns
- Syntax: Smalltalk + Meta Variables
- Example:

```
| `@Temps |
``@.Statements.
``@Boolean ifTrue: [^false].
^true
```

Meta Variables

All Meta Variables begin with `

Character	Type	Example
`	recurse into	``@object foo
@	list	| `@Temps | `@.statements
.	statement	`.Statement
#	literal	`#literal

Example 1

- Search for: ``@object not ifTrue: ``@block

- Replace with: ``@object ifFalse: ``@block

- Explanation:
  - Eliminate an unnecesary not message

Example 2

- Search for:

```
| `@Temps |
``@.Statements.
``@Boolean ifTrue: [^false].
^true
```

- Replace with:

```
| `@Temps |
``@.Statements.
^``@Boolean not
```

- Explanation:
  - Return the value of the boolean negated instead of using a conditional

Implementation: Model and Environment

- Model Code transformed but not installed
  - We need to be able to see refactored code without changing the system.
  - RBNameSpace

- Model Classes + Methods
  - Framework duplicates Smalltalk‘s structural Reflection
  - RBClass, RBMethod

- Model Scope to which Refactorings apply
  - RBEnvironment

Back to Code: Pretty Printer

- Visitor: Walks the AST
- Prints out text for each node

- Problem: How to preserve formatting?
  - AST saves formatting (whitespace, parenthesis)
  - Pretty Printer can use saved formatting information

Contributions needed

- Improved UI
- Integrated Parser with Squeak NewCompiler
  - Scanner/Parser done with tool (SmaCC)
  - Easier to change / experiment
- Integrated RoelTyper
  - Heuristical type inference
- Better PrettyPrinter
  - Configurability
  - Better Layout

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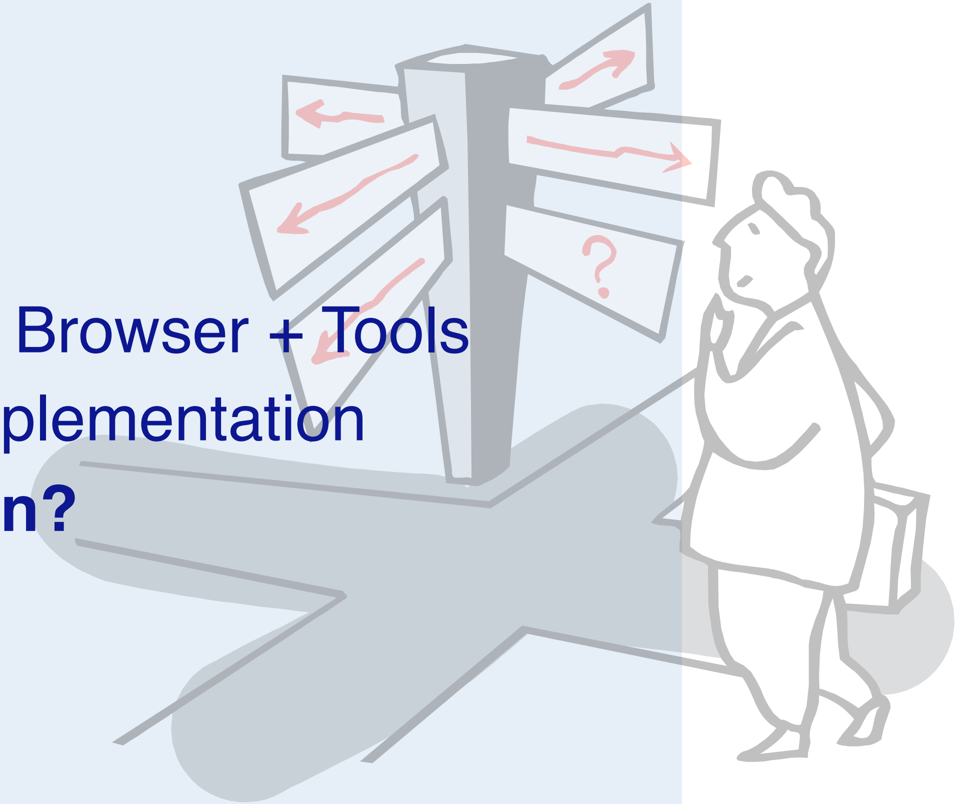


Reflection?

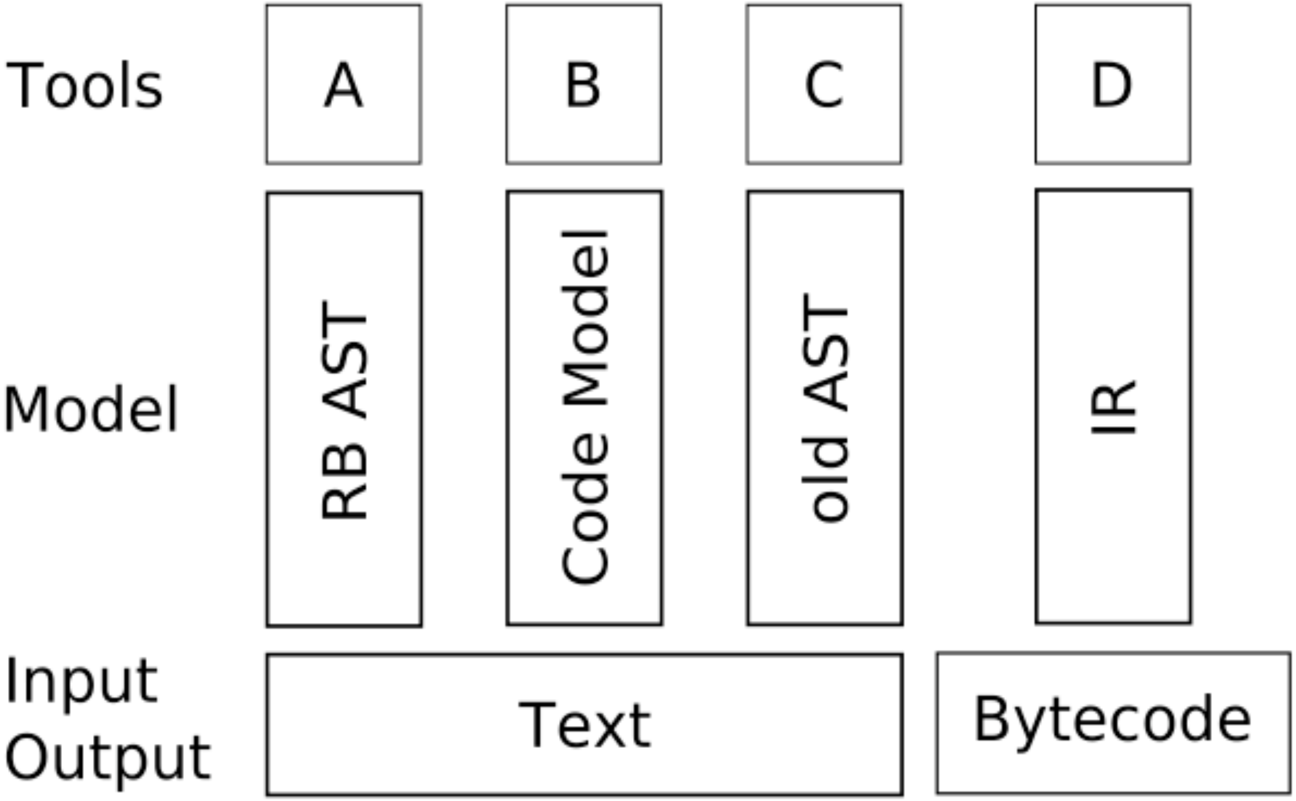
- We change the system using itself
  - So it‘s Reflection, on some level

- But: Let‘s look again at the definition
  - Model of itself
  - Causally connected

- We Build our own abstraction layer
  - AST + Environment

- This Model is <u>not</u> causally connected!

State Today

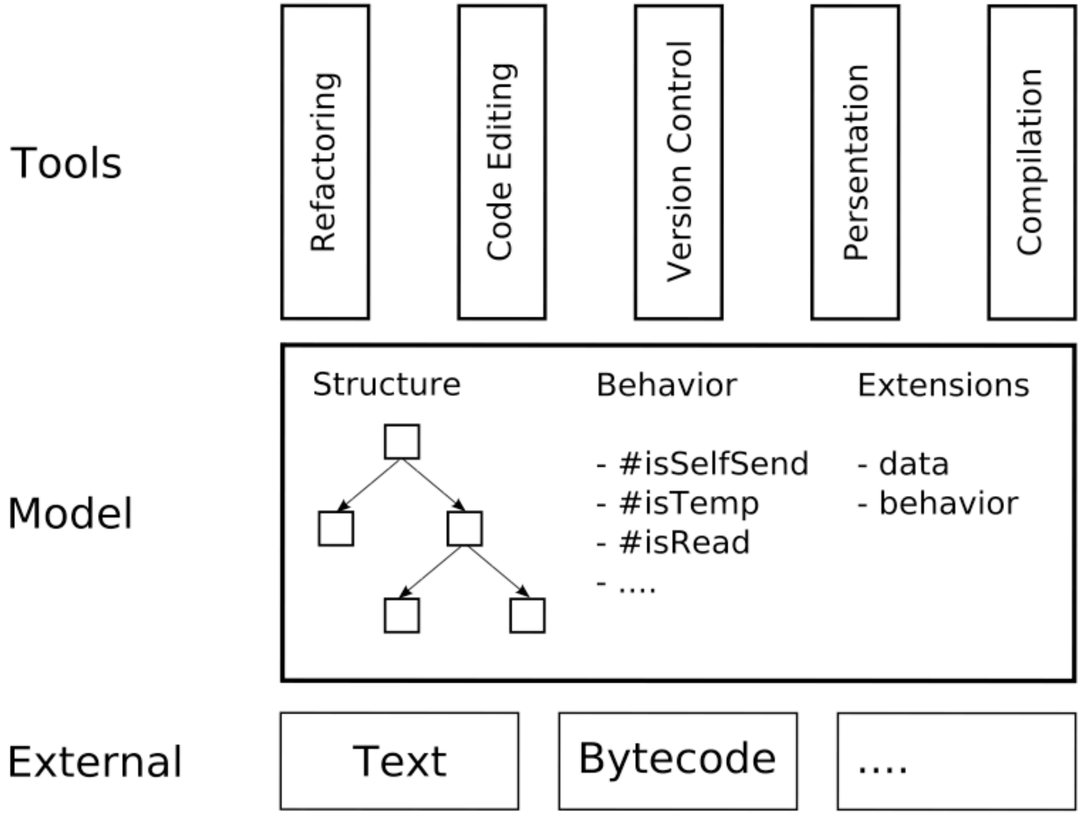


Tools
A
B
C
D

Model
RB AST
Code Model
old AST
IR

Input
Output
Text
Bytecode

Why not this?



Tools

Refactoring

Code Editing

Version Control

Persentation

Compilation

Model

Structure

Behavior

- #isSelfSend
- #isTemp
- #isRead
- ....

Extensions

- data
- behavior

External

Text

Bytecode

....

We have seen...

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Questions?

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