Advanced Reflection in Pharo

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What you know…

- Smalltalk is reflective
- e.g. Classes and Methods are Objects
- Reflective API on all Objects

Instance Variables

2 instance variables

```
Object subclass: #Point
    instanceVariableNames: 'x y'
    classVariableNames: ''
    poolDictionaries: ''
    category: 'Kernel-BasicObjects'
```

- Ask the class:

```
Point instVarNames
```

- read:

```
3@4 instVarNamed: #x
```

- write:

```
3@4 instVarNamed: #x put: 5
```

Great!

But…

This is just a String!

```
Object subclass: #Point
    instanceVariableNames: 'x y'
    classVariableNames: ''
    poolDictionaries: ''
    category: 'Kernel-BasicObjects'
```

- returns an Array of Strings:

```
Point instVarNames
```

Why not Objects?

We can do better!

- All classes have a **Layout**

- Describes the **memory layout** defined by a class

- Layout and all the description are **Objects**

- `Point layout`
  - a Normal Object
- `Array layout`
  - an Array of Pointers
- `ByteArray layout`
  - an Array of Bytes

```
Point layout allSlots
```

```
==>  an OrderedCollection(x => Slot y => Slot)
```

- Slots know how to read values from Objects

```
mySlot := Point layout resolveSlot: #x.

mySlot read: 3@4.
```

Why?

Typed Slots

```
Slot subclass: #TypedSlot
    layout: PointerLayout
    slots: {#x => TypedSlot type: Integer}.


TypedSlot >> write: aValue to: anInstance
    (aValue isNil or: [aValue isKindOf: type])
        ifFalse: [ InvalidTypeError signal ].
    super write: aValue to: anInstance.
```

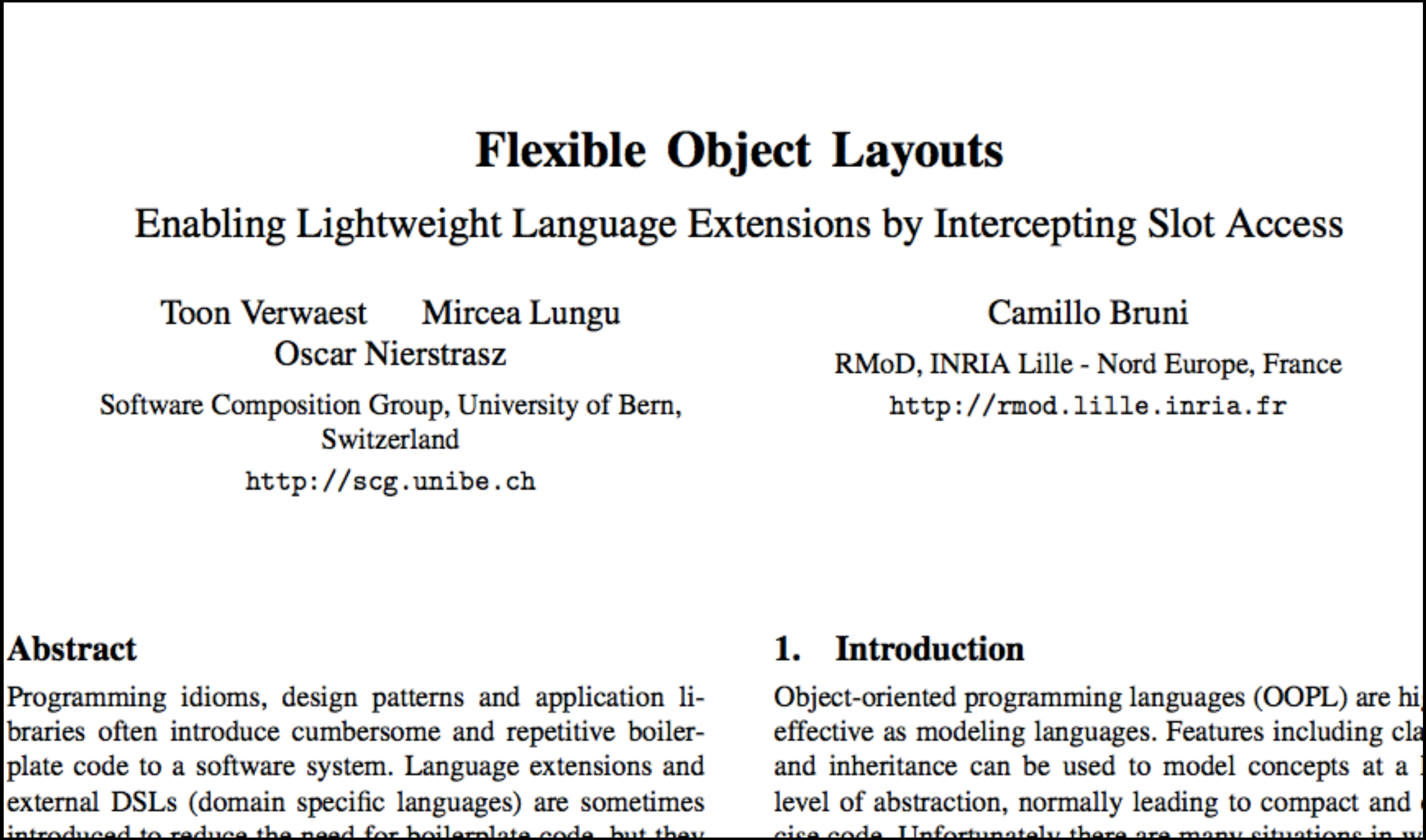
Property Slots

```
Object
    subclass: #PropertyObject
    layout: PointerLayout
    slots: {
        field     => Slot
        property1 => PropertySlot.
        property2 => PropertySlot.
        ...
        propertyN => PropertySlot.
    }
```

Others

- BitSlot
- BooleanSlot
- Alias
- Relationships (e.g. one-one, one-many)
- …. Your Domain level Slot!

More in Paper from OOPSLA



Flexible Object Layouts

Enabling Lightweight Language Extensions by Intercepting Slot Access

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Abstract

Programming idioms, design patterns and application libraries often introduce cumbersome and repetitive boilerplate code to a software system. Language extensions and external DSLs (domain specific languages) are sometimes

1. Introduction

Object-oriented programming languages (OOPL) are hi
effective as modeling languages. Features including cla
and inheritance can be used to model concepts at a
level of abstraction, normally leading to compact and

Status

- Slots are in Pharo3, but hidden
- In Pharo4: un-hide and introduce some Special Slots (e.g. Boolean, Property)
    - e.g. for Morphic (user interface objects)

Help Wanted!!!

So this worked well…

Lets do it again!

Turn another String into Objects

:-)

Methods

Lets have a look

- Method are Objects, but…
- No high-level model for sub-method elements
  - Message sends
  - Assignments
  - Variable access
- Structural reflection stops at the granularity of methods!

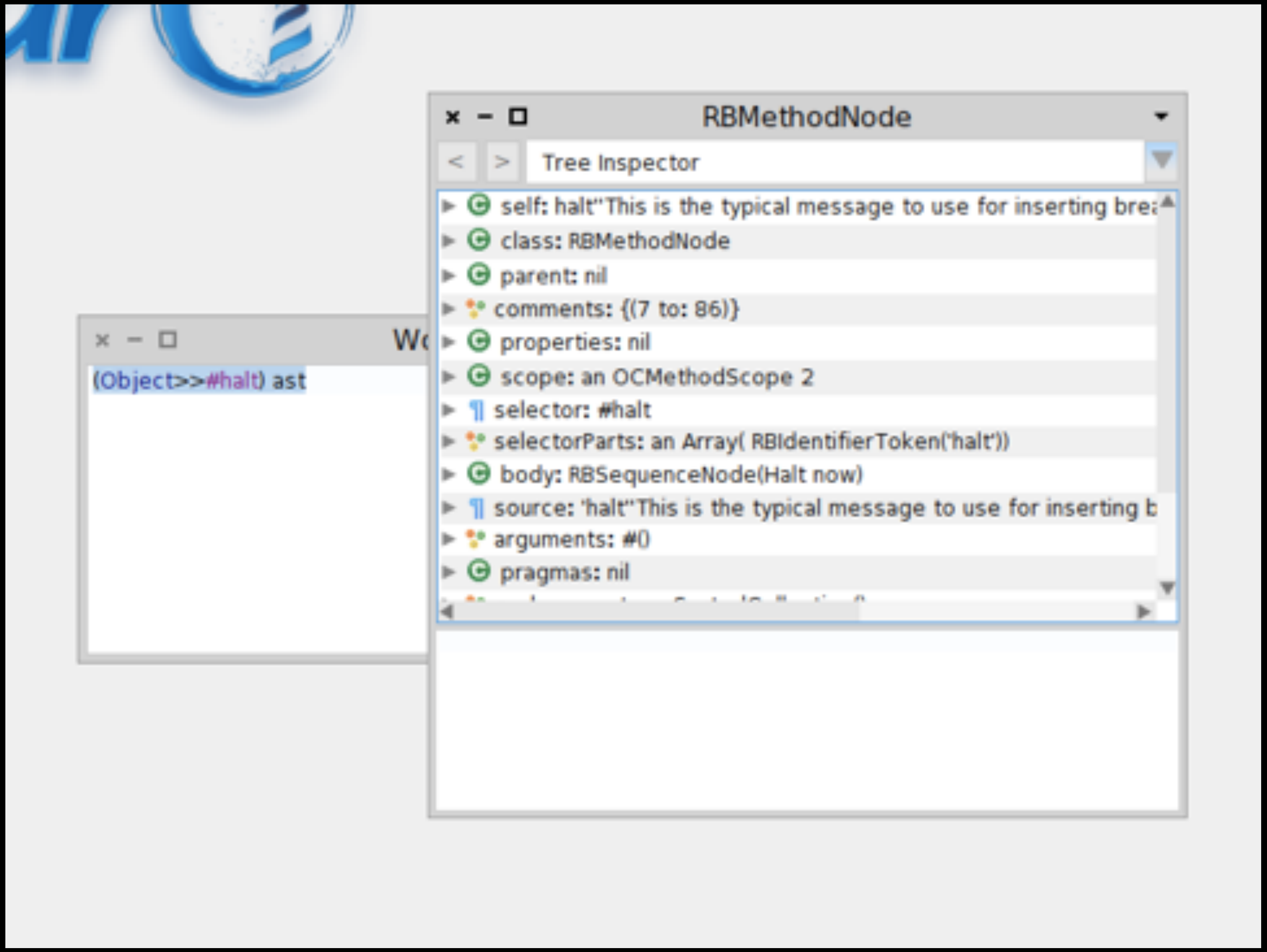
Can we do better?

Compilers have ASTs

Abstract **S**yntax **T**rees

- Lets have a look at an example

```
(Object>>#halt) ast
```



```
(Object>>#halt) ast
```

RBMethodNode

Tree Inspector

```
self: halt"This is the typical message to use for inserting brea
class: RBMethodNode
parent: nil
comments: {(7 to: 86)}
properties: nil
scope: an OCMethodScope 2
selector: #halt
selectorParts: an Array( RBIdentifierToken('halt'))
body: RBSequenceNode(Halt now)
source: 'halt"This is the typical message to use for inserting b
arguments: #()
pragmas: nil
```

- Encodes the method as a tree of node-objects
- Visitor Pattern
- Transformations
    - Refactoring tool uses this!

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

In Pharo3

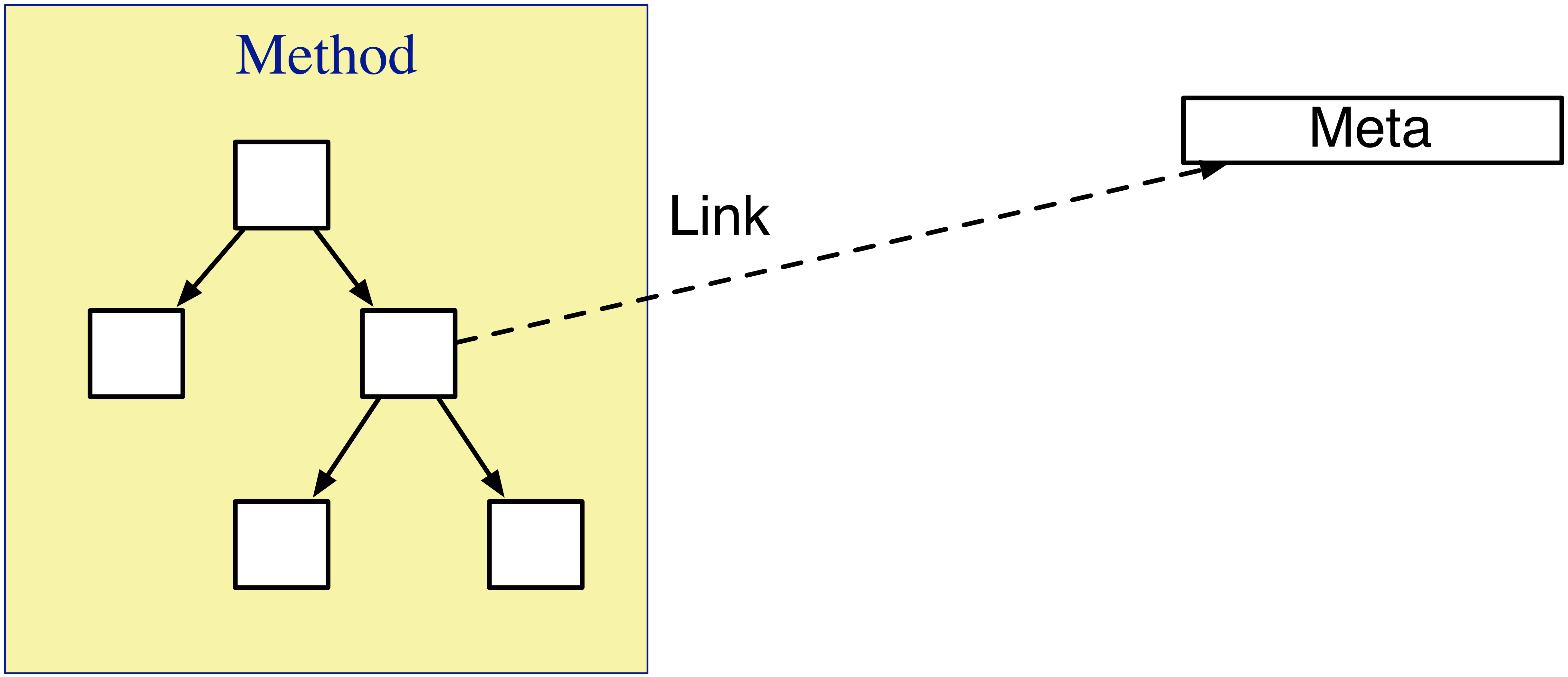
- AST based Navigation in the Editor
- “Suggestions”
- Debugger uses AST for pc->code mapping
- AST Interpreter for experiments

Future

- AST everywhere!
- Do we need to store strings?
- Can we have an AST based editor?
- Sub-Method Reflection: The MetaLink

Can we modify the behaviour of code?

- Annotate the AST with meta-links



Why?

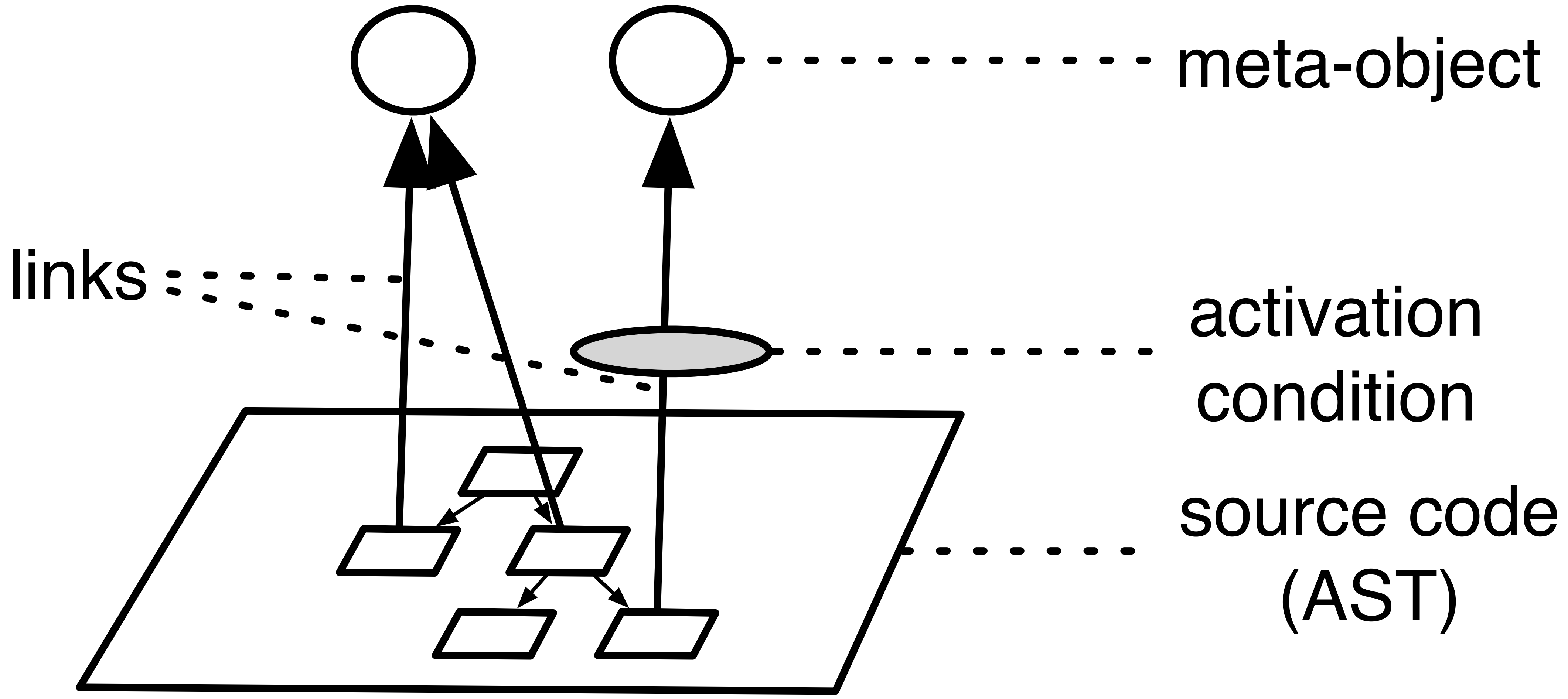
- Change behaviour for selected AST Nodes
- “All assignments”
- “this message send”

But without changing the program code!

Breakpoints

DEMO: Atoms

Behavioral Reflection



Uses…

- Debugger
    - BreakPoints, WatchPoints
- Profilers
- Coverage Analysis
- AOP

Will be in Pharo4

Will be in Pharo4

!!help wanted!!

What did we see?

- **Slots**
  - Instance variables are just described with strings
  - We can do better! Layout, Slots
- **ASTs Everywhere**
  - Methods are objects, but internal structure not modelled
  - We can do better! AST, Sub-Method Reflection, Meta-Links

Questions???