Beyond Text - Methods As Objects

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Software Composition Group University of Berne

- Lead by Oscar Nierstrasz and Stephane Ducasse
- Overall Focus: Software Evolution
- Two parts:
  - Evolution of Existing Systems (Reengineering)
    - *Moose, CodeCrawler*
  - Language Design for enabling Evolution
    - *Traits*
    - *ClassBoxes*

- Forward and Reverse engineering viewpoints
  - We start to see many parallels / cross fertilization

Roadmap

- Reflective Systems
  - Behavioral Reflection
  - Squeak’s Reflective capabilties
- Methods in Squeak
  - Methods as Objects
  - Objects as Methods
- ByteSurgeon and Geppetto
  - Usage
  - Problems
- Beyond text

Reflection

- > Object oriented model of the system available inside the system
  - — called “Introspection”
  - — Java
- > Model is *causally connected*
  - — Changing this model changes the system
  - — called “Intercession”
- > Reflection = Introspection + Intercession

Behavioral and Structural

> Structural reflection: changing structure
  - Add / remove classes and methods
  - Add / remove instance variables
  - Change inheritance relationship

> Behavioral reflection: changing behavior
  - What is inheritance?
  - Hook into instance variable stores (e.g. persistence)

> Both are related
  - change of structure changes behavior

Usage: Why Reflection

> Structural reflection
  - Changing systems at runtime
  - Powerful development environments (no edit-compile-run)
  - Analysis (through introspection)

> Behavioral reflection
  - Language experiments
  - Debugging
  - Dynamic analysis (tracing, visualization)
  - New language features (e.g. persistence)

Squeak: A Reflective System

> Squeak: open source Smalltalk
  - Classes and methods are objects
  - Changing these objects changes the system (at runtime)

> API for
  - adding / removing classes + methods
  - adding / removing instance variables
  - changing inheritance relationship

Squeak: Behavioral Reflection

> Behavioral Reflection: only by changing methods

> There is no API for introspection/intercession of
  - Instance variable access
  - Temp variable access
  - Message sending
  - Message lookup
  - Method execution

Structural Reflection enables Behavioral Reflection

> General: Change of structure changes behavior
> We can use the structural reflection API to provide behavioral reflection
  - Methods are objects
  - We can just replace them with our version that does what we want

Behavioral Reflection: Howto?

> Method Wrappers (e.g. used by AspectS)
  - Gives access to before / after of method execution
> Squeak's Objects-As-Methods
  - we can install any object as a method that implements a simple protocol (#run:with:in)
  - used by ClassBoxes, FacetS
  - reifies method execution

> Transformation of text / AST / Bytecode

ByteSurgeon

- Framework for editing bytecode for Squeak
  - Like Javasist in Java, but:
- Uses structural reflection to transform at runtime
  - Simple model: Inline code before / after a bytecode
  - Inlined code is normal smalltalk code
  - Not much knowledge about bytecode needed

Example for Bytesurgeon I

> Goal: Logging Message send

```
example
     self test.
```

```
example
    Transcript show: ‘sending #test’.
    self test.
```

Example for Bytesurgeon II

> Goal: Log message send
> with ByteSurgeon:

```
(Example>>#example) instrumentSend: [:send |
   send insertBefore:
            'Transcript show: ''sending #test'' '.
]
```

Uses of ByteSurgeon at SCG

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- Implementation of fast MethodWrapper
  - 35 lines of code
- Trace library for runtime tracing
- Back-In-Time Debugger
- Runtime analysis: test coverage

Problems of ByteSurgeon

- Performance
  - Faster then code / AST
  - But installation takes some time
- Abstractions too low level
  - Bytecode
  - We want to abstract away from bytecode and talk about instance variable access, message sending...
  - Not a good meta model

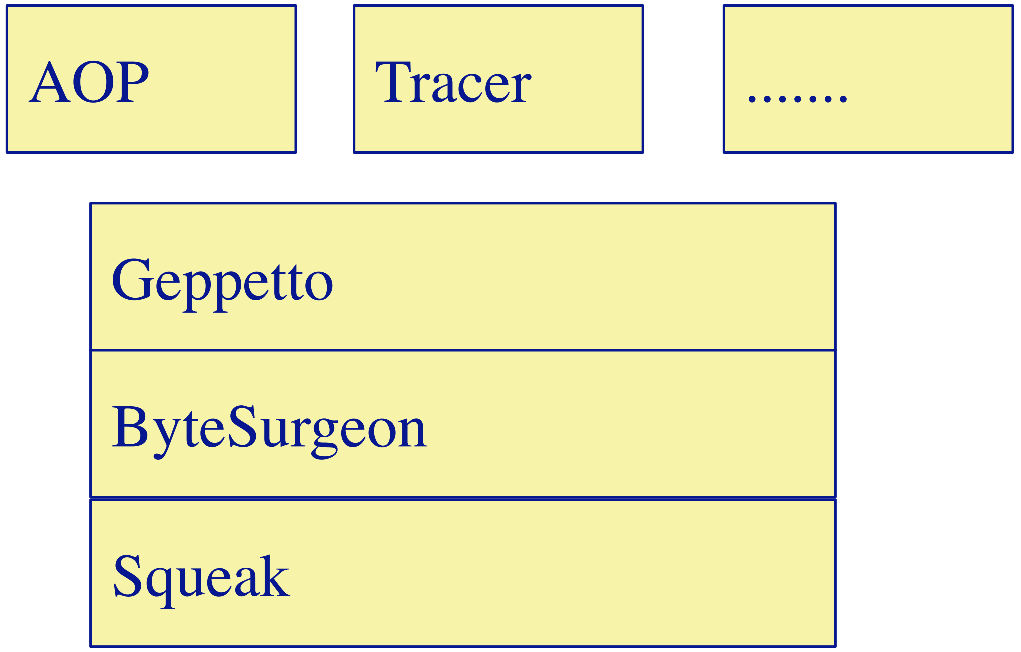
Geppetto

- Framework for behavioral reflection
- Build on top of ByteSurgeon
  - but abstracts from bytecode

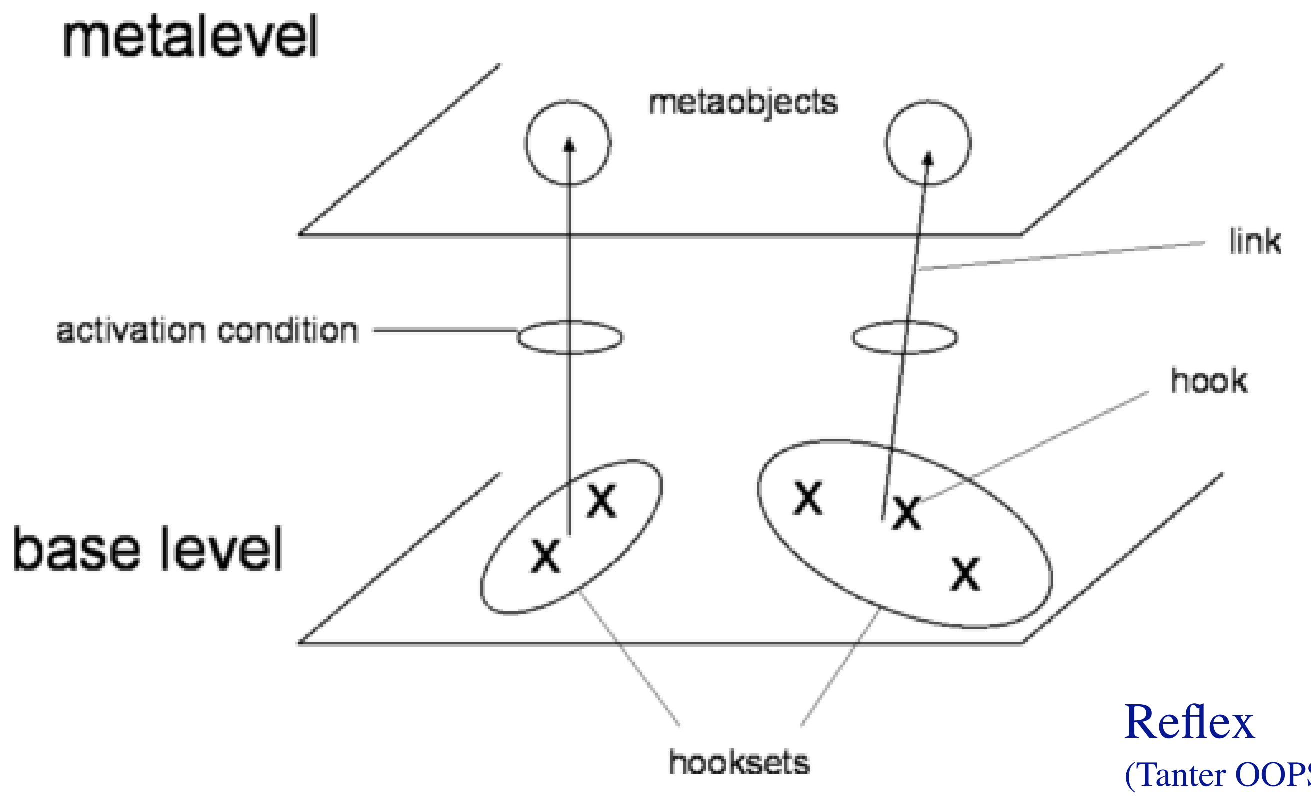
- Fine grained scoping of reflection
  - spatial (where? and what?)
  - temporal (when?)

- Based on the Reflex Model (Eric Tanter)

Geppetto: Big Picture



Geppetto: Modell



Reflex
(Tanter OOPSLA 03)

Problem with Bytecode in Geppetto

- Bytecode is not a good meta model
- Lots of management infrastructure is needed
  - Hook composition
  - Synthesised elements (hooks) vs. original code
  - Mapping to source elements
- Bytecode is optimized
  - e.g. no ifTrue:

Beyond Text: A Meta Model for Methods

- We need a high-level meta model for methods
- This model needs to be causally connected
  - edit the model --> edit the system

- Text and Byte- (Binary-) code generated on demand

Beyond Text: A Meta Model for Methods

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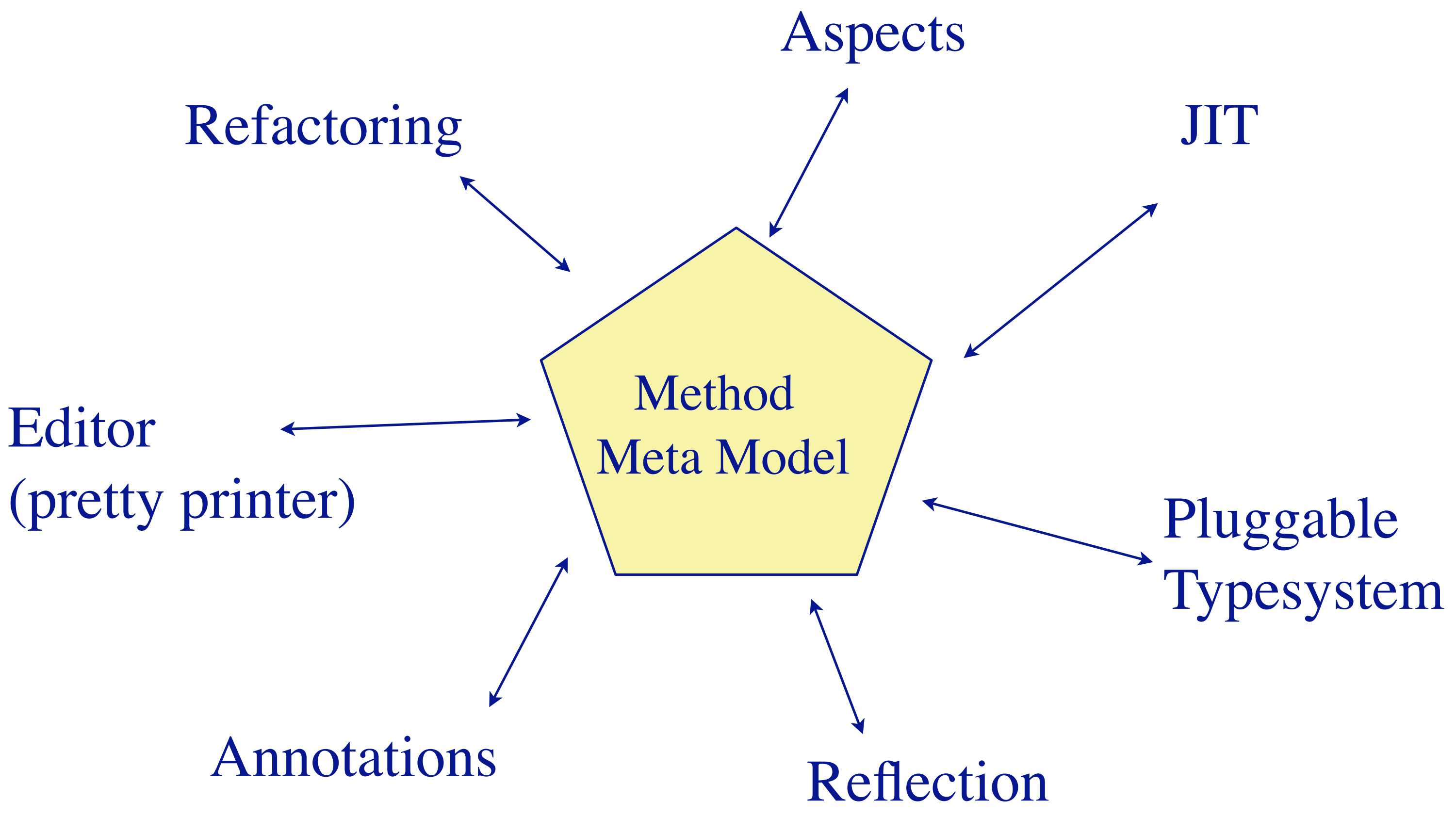
- Structure of method is implicit
  - Compile text (to AST)
  - Decompile bytecode (to IR or AST)

- Both text and bytecode are pretty low level
- Not suited for being the main representation
  - How to annotate text?
  - How to tag synthesised bytecode?

- Possible Model: AST

Many users


Aspects
Refactoring
JIT
Method Meta Model
Editor (pretty printer)
Pluggable Typesystem
Annotations
Reflection

Explorations...

> Annotation framework
  - Nodes can be annotated
  - We can have any object as a (non-textual) annotation

> replace ByteSurgeon by AST based transformer

> Idea: Behavioral Reflection with Annotations

> Combine with AspectS for dynamic Aspects

Conclusion

> We have had a quick intro in Reflection
  - Squeak and how it enables reflection

> How to realize behavioral reflection
  - Bytesurgeon and Geppetto
  - Problems

> We need a Meta Model for Methods

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