PINOCCHIO

Bringing Reflection to Life with First-Class Interpreters

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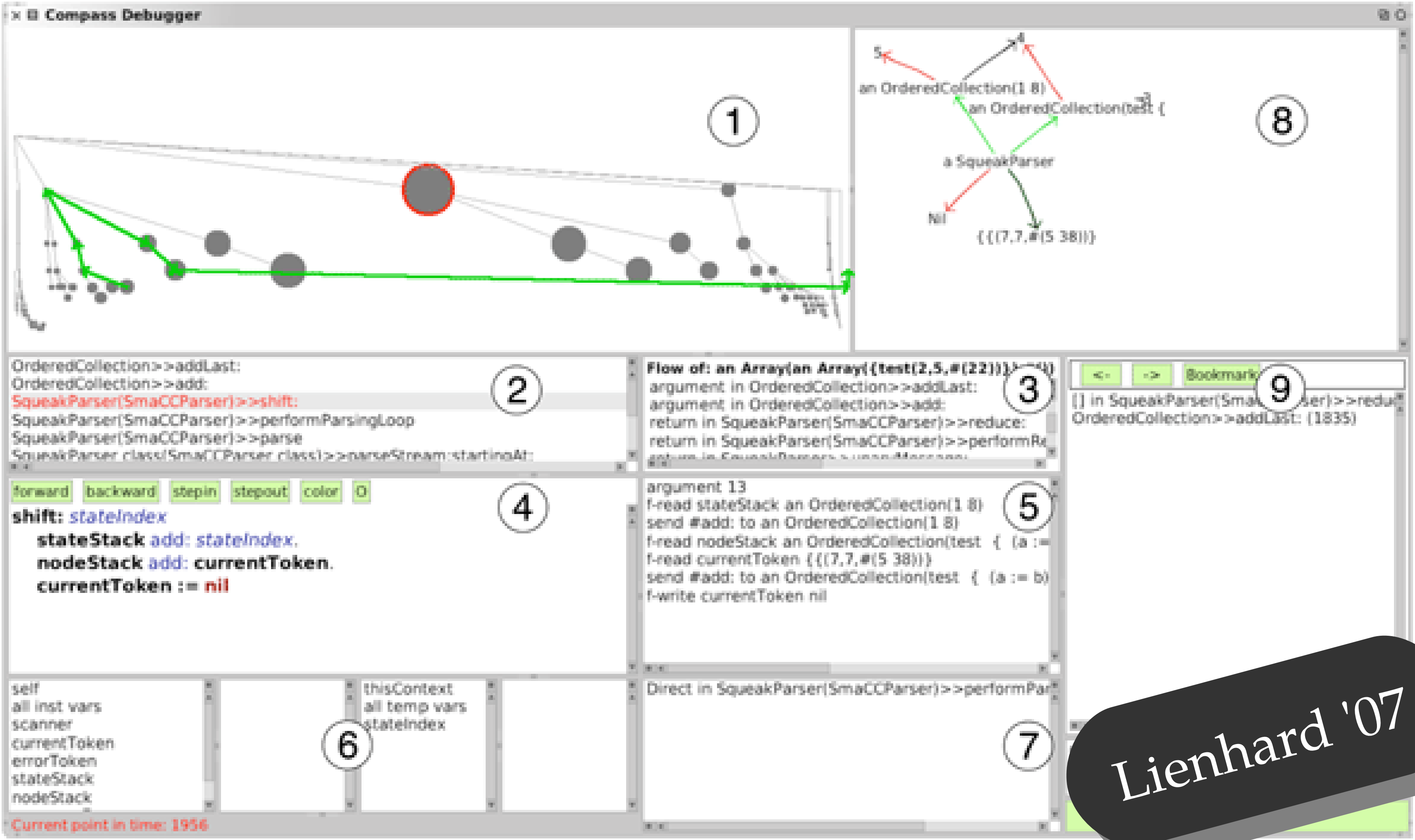
debugging is *hard*

developing debuggers is

even harder

```
System.out.println
```

Object-Flow Debugger



```
OrderedCollection>>addLast:
OrderedCollection>>add:
SqueakParser(SmaCCParser)>>shift:
SqueakParser(SmaCCParser)>>performParsingLoop
SqueakParser(SmaCCParser)>>parse
SqueakParser class(SmaCCParser class)>>parseStream:startingAt:
```

```
Flow of: an Array(an Array({test(2,5,#(22))}
argument in OrderedCollection>>addLast:
argument in OrderedCollection>>add:
return in SqueakParser(SmaCCParser)>>reduce:
return in SqueakParser(SmaCCParser)>>performRe
return in SqueakParser>>unaryMessage:
```

```
[] in SqueakParser(SmaCCParser)>>redu
OrderedCollection>>addLast: (1835)
```

```
shift: stateIndex
    stateStack add: stateIndex.
    nodeStack add: currentToken.
    currentToken := nil
```

```
argument 13
f-read stateStack an OrderedCollection(1 8)
send #add: to an OrderedCollection(1 8)
f-read nodeStack an OrderedCollection(test  (  (a :=
f-read currentToken {{(7,7,#(5 38))}
send #add: to an OrderedCollection(test  (  (a := b)
f-write currentToken nil
```

```
self
all inst vars
scanner
currentToken
errorToken
stateStack
nodeStack
```

```
thisContext
all temp vars
stateIndex
```

```
Direct in SqueakParser(SmaCCParser)>>performPar
```

Current point in time: 1956

Lienhard '07

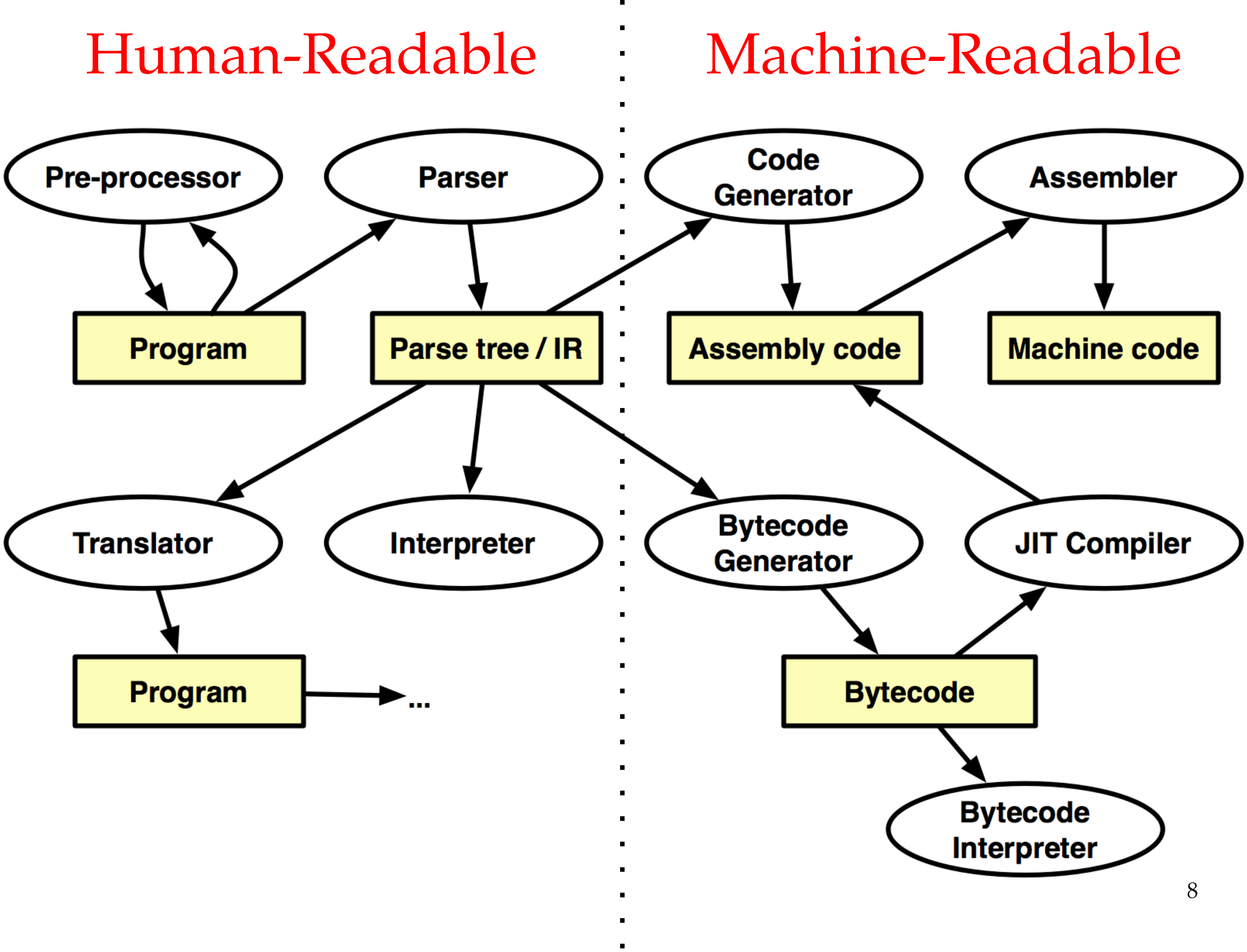
modifications to the Virtual Machine

A programming language

is a notational system for describing computation

in a machine-readable and human-readable form.

— *Louden*


Human-Readable
Machine-Readable
Pre-processor
Parser
Code Generator
Assembler
Program
Parse tree / IR
Assembly code
Machine code
Translator
Interpreter
Bytecode Generator
JIT Compiler
Program
...
Bytecode
Bytecode Interpreter

What if we

could build a

specialized debugger

in *just a few hours?*

modify the interpretation

in the language itself

in terms of

the source code

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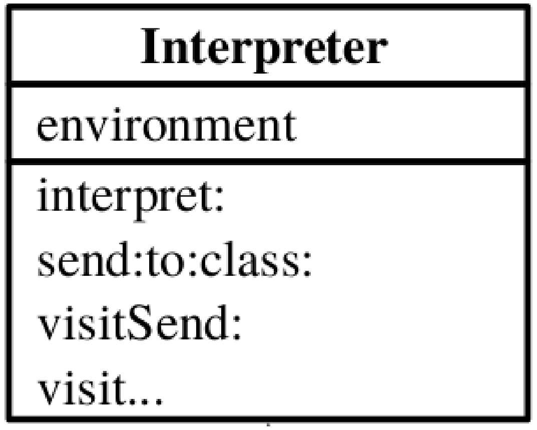
Interpreter
environment
interpret:
send:to:class:
visitSend:
visit...

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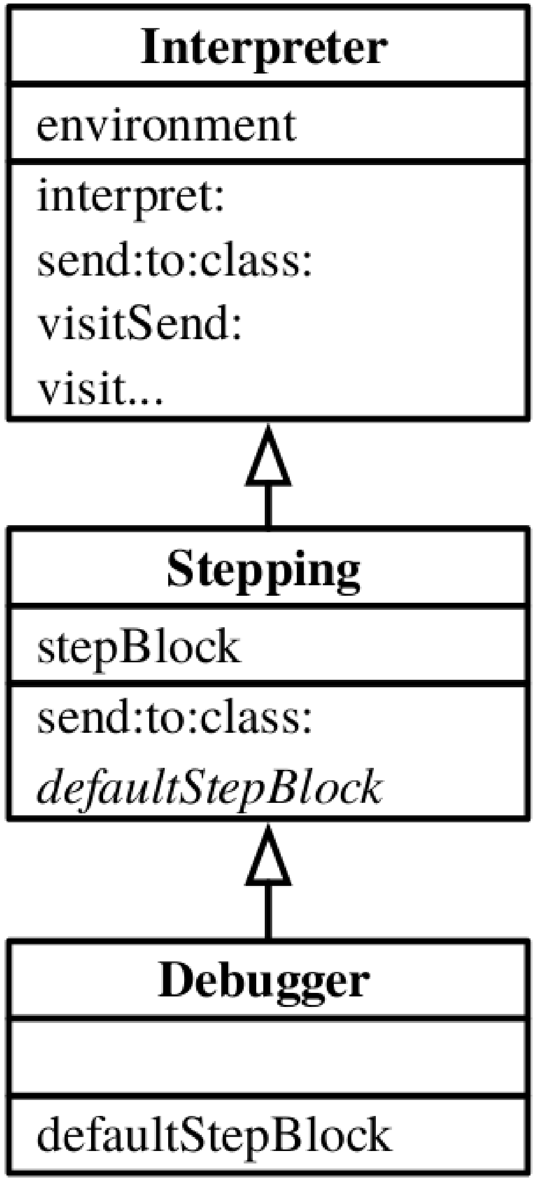
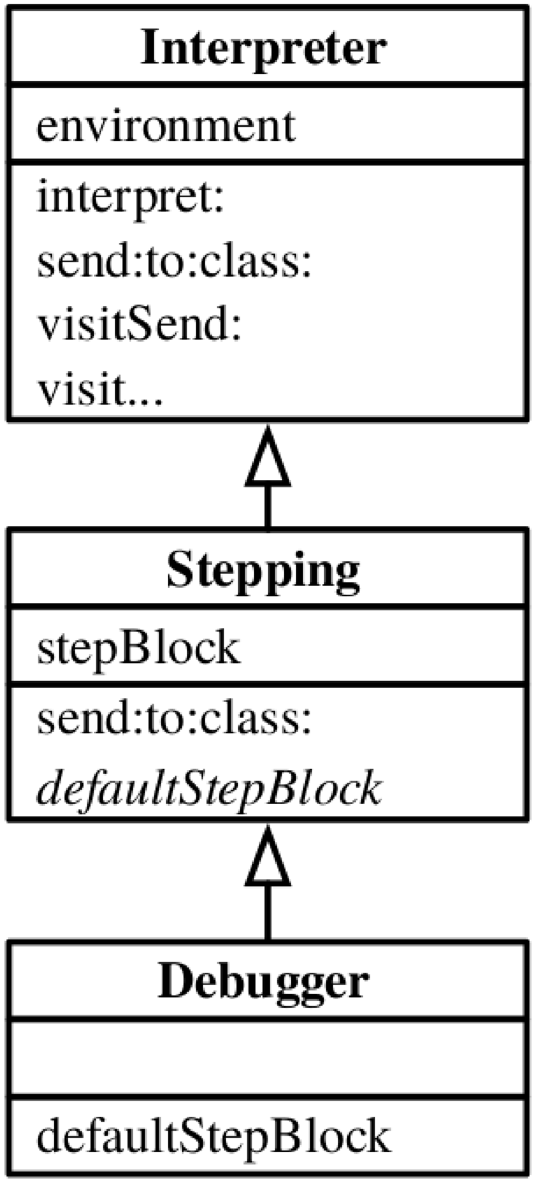

Interpreter
environment
interpret:
send:to:class:
visitSend:
visit...
Stepping
stepBlock
send:to:class:
defaultStepBlock
Debugger
defaultStepBlock

```
Debugger interpret: [ Person new ]
Debugger interpret: [ Person new ]
```

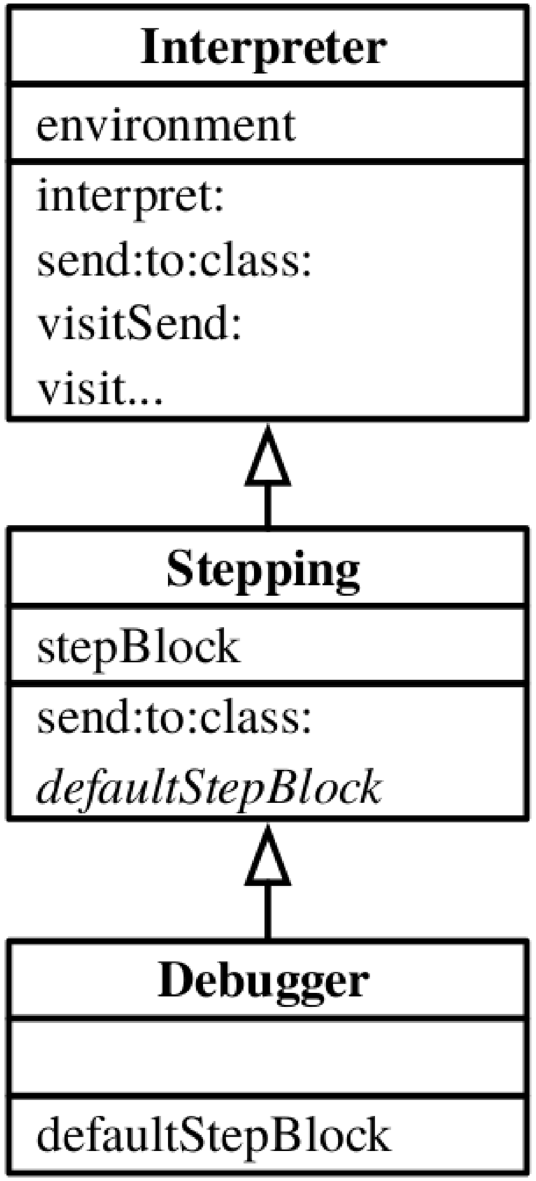
structural reflection

continuous behavioral reflection



```
send: message to: receiver: class: class
    self print:
        receiver class name, '>>', message.

    ^ self debugShellWithAction:[
        super
            send: message
            to: receiver
            class: class ]
```

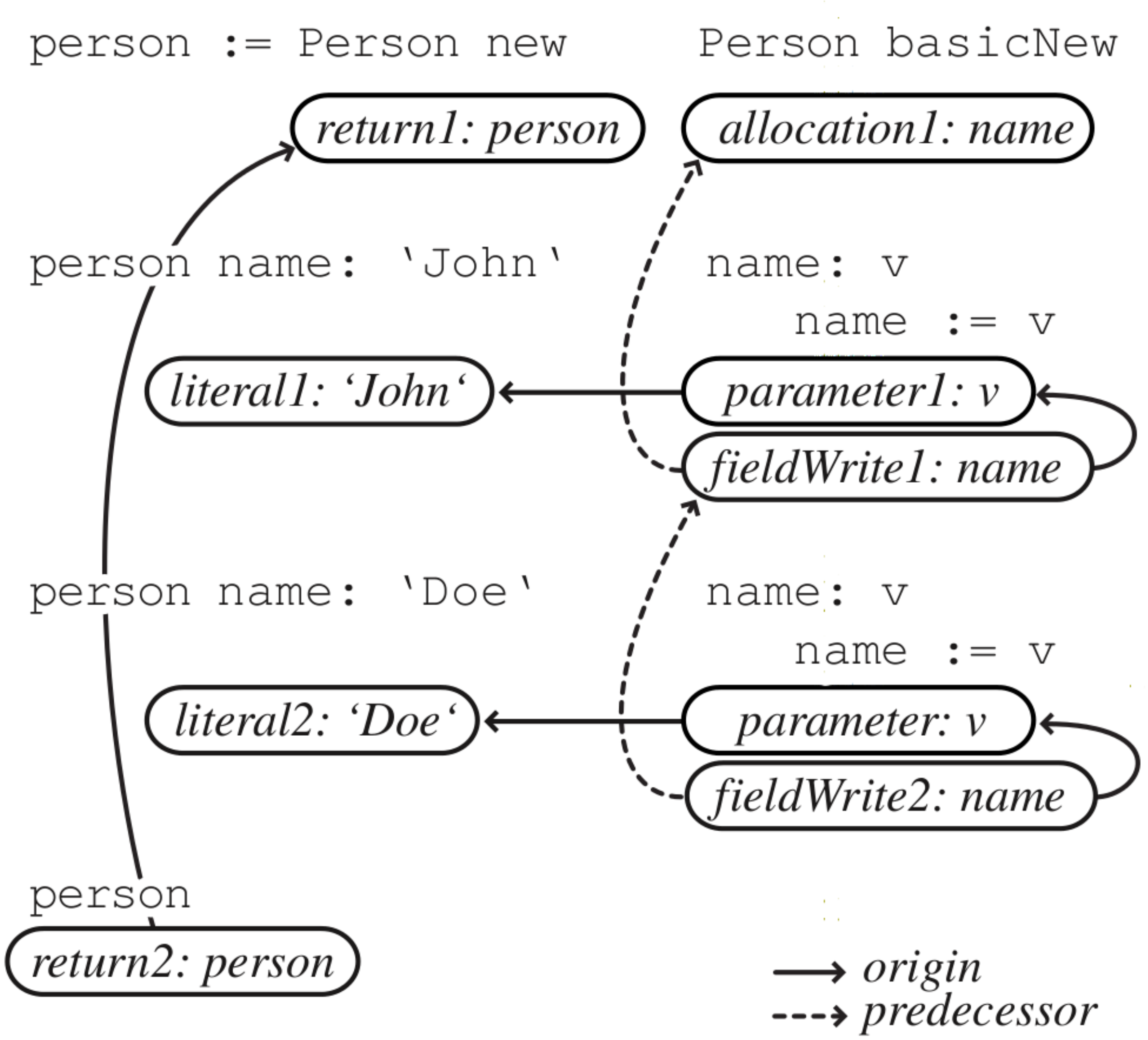


recursive AST visitors

garbage collection

object model

Alias Interpreter



```
AliasInterpreter
              interpret: [
   p := Person new.
   p name: 'John'.
   p name: 'Doe'.
]
```

Alias Interpreter

```
interpretMethod: method
   | result |
   result := super interpretMethod: method.
   ^ (ReturnAlias alias: result)
      environment: environment
```

Performance *(fib)*

Pinocchio	2x slower than Pharo
	2x slower than Ruby 1.9
	2x faster than Python 2.6.4
	5x faster than Ruby 1.8
Metacircular	160x slower Pinocchio

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Java	160x faster than Ruby 1.8

PINOCCHIO

- recursive AST visitors
- extensible using OO techniques
- implemented practical debuggers

Future work

- performance is not addressed yet