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Declarative Reasoning about the Structure of Object-Oriented Systems

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Overview

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4. SOUL
5. Declarative Framework
6. Example
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8. Conclusion

1. Introduction

- Evolution in OO Software Engineering: extend reusability, adaptibility, maintainibility, …

  from implementation to design
- Drawbacks:
  - current implementations form tangled web of communicating objects
  - No explicit link between design structures and code

1. Introduction (ctd)

- Link between implementation and design is lost

  ⇨ No support for design techniques like for example design patterns

- Making the link:
  - ***Query*** an existing system
  - ***Enforce*** in new system

1. Introduction (ctd)

- In the development process there is a need to reason on a high-level about the structure of object-oriented systems

  ⇨ explicit, general, declarative system to express and extract structural relationships in class-based object-oriented systems.

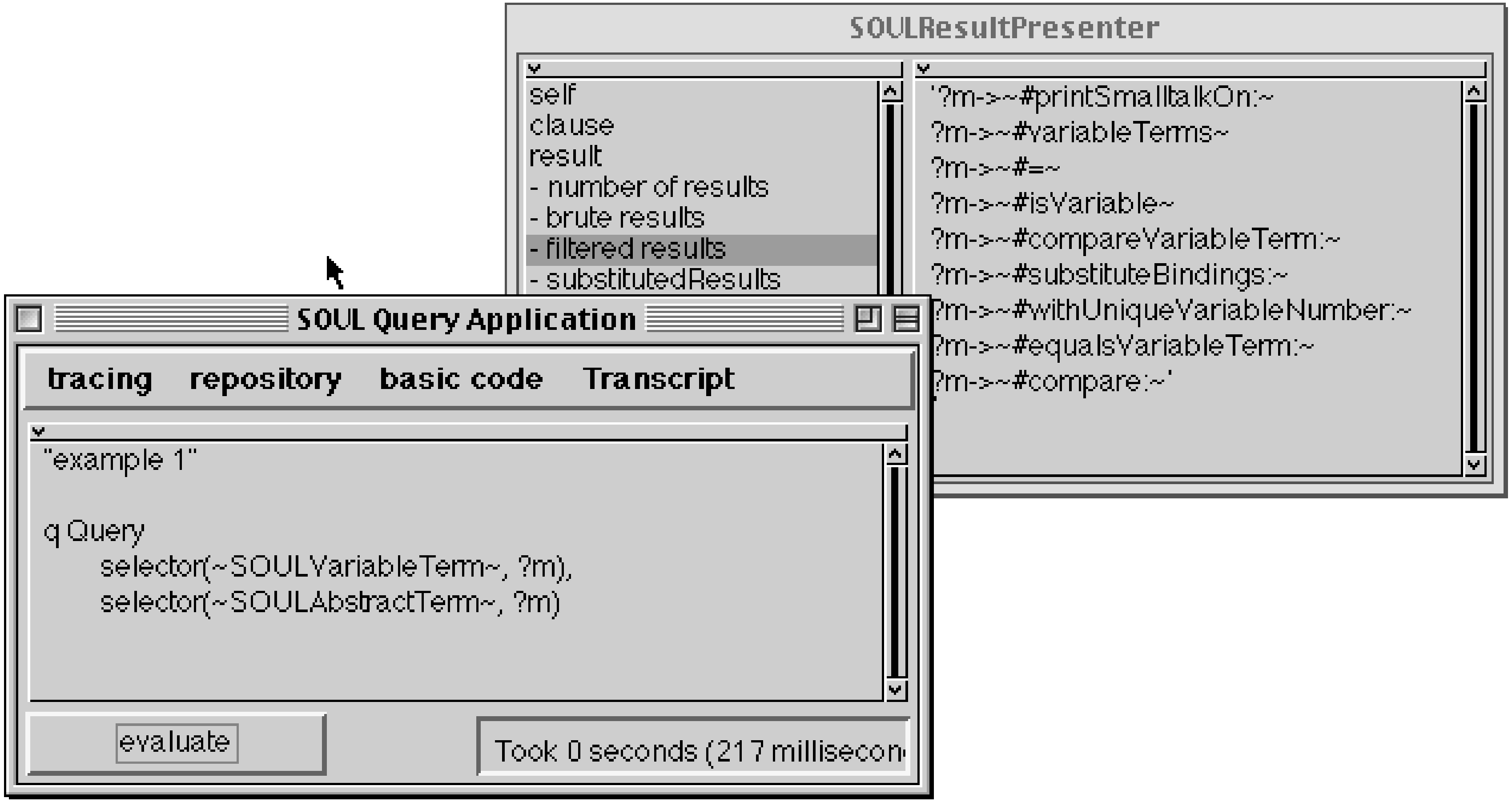
2. Example

- Express structural information
  - For querying an existing system
  - For enforcement

- Common Methods:

```
Query
    selector(?class1,?method),
    selector(?class2,?method)
```

2. Example (ctd)



```
"example 1"

q Query
	selector(~SOULVariableTerm~, ?m),
	selector(~SOULAbstractTerm~, ?m)
```

```
'?m->~#printSmalltalkOn:~
?m->~#variableTerms~
?m->~#=~
?m->~#isVariable~
?m->~#compareVariableTerm:~
?m->~#substituteBindings:~
?m->~#withUniqueVariableNumber:~
?m->~#equalsVariableTerm:~
?m->~#compare:~'
```

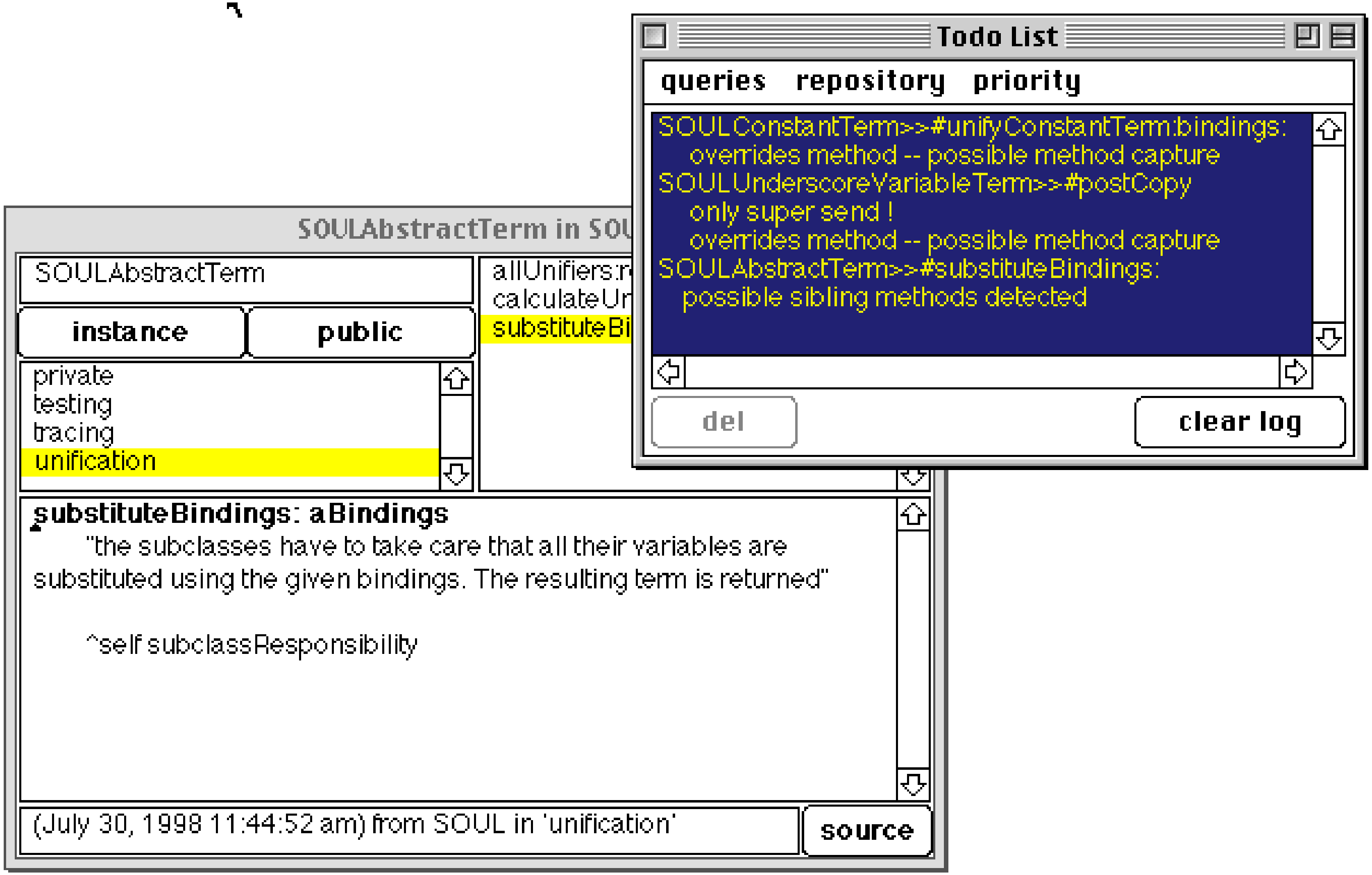
Took 0 seconds (217 millisecon

2. Example (ctd)

“detect possible refactoring of sibling methods for ?MyClass and ?myMethod”

```
Query
  hierarchy (?supers,?MyClass),
  not(selector(?supers,?myMethod)),
  hierarchy(?supers,?others),
  not(equals(?others,?MyClass)),
  selector(?others,?myMethod)
```

2. Example (ctd)



```
SOULConstantTerm>>#unifyConstantTerm:bindings:
   overrides method -- possible method capture
SOULUnderscoreVariableTerm>>#postCopy
   only super send !
   overrides method -- possible method capture
SOULAbstractTerm>>#substituteBindings:
  possible sibling methods detected
```

```
substituteBindings: aBindings
	"the subclasses have to take care that all their variables are substituted using the given bindings. The resulting term is returned"

	^self subclassResponsibility
```

(July 30, 1998 11:44:52 am) from SOUL in 'unification'

2. Example (ctd)

`“find sibling methods, and compare their method bodies to find identical statements”`

```
Query
  siblings(?MyClass,?myMethod,?c),
  statements(?MyClass,?myMethod,?myStats),
  statements(?c,?myMethod,?stats),
  commons(?myStats,?stats,?commonStats)
```

3. Specifications

A system for declarative reasoning about structure of OO Systems should be:

- ***open:*** the elements of reasoning (e.g. classes, methods, parse trees) should not be fixed
- ***language independent***
- ***causally connected:*** there should be synchronisation between the declarative representation of the code and the code itself
- ***enforced:*** integration with the programming environment in order to enforce constraints

4. SOUL

- SOUL (Smalltalk Open Unification Language): first step towards declarative system to reason about structure
- Prolog-like, but
  - unification on general, user-definable elements because of “Smalltalk terms”: bridge between SOUL and implementation language
- ⇨ Smalltalk meta-language

4. SOUL (ctd)

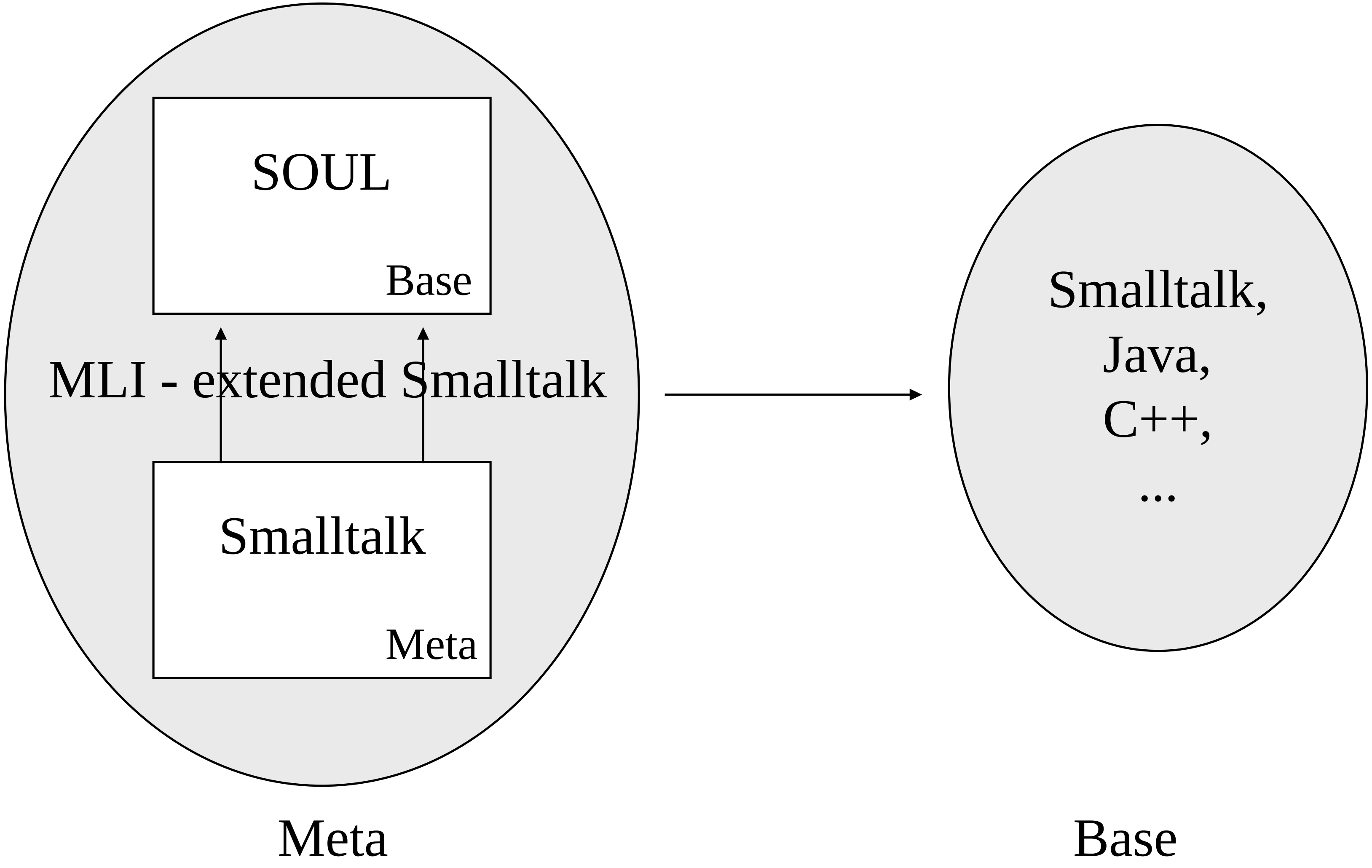
- ‘Smalltalk Term’: contains Smalltalk code extended with logic variables

```
Rule class(?c)
if
   constant(?c),
   [Smalltalk includes: ?c name].
```

Smalltalk Term, checks ?c

```
Rule class(?c)
if
   variable(?c),
   generate(?c, [Smalltalk allClasses]).
```

4. SOUL (ctd)



SOUL

Base

MLI - extended Smalltalk

Smalltalk

Meta

Smalltalk,
Java,
C++,
...

Meta

Base

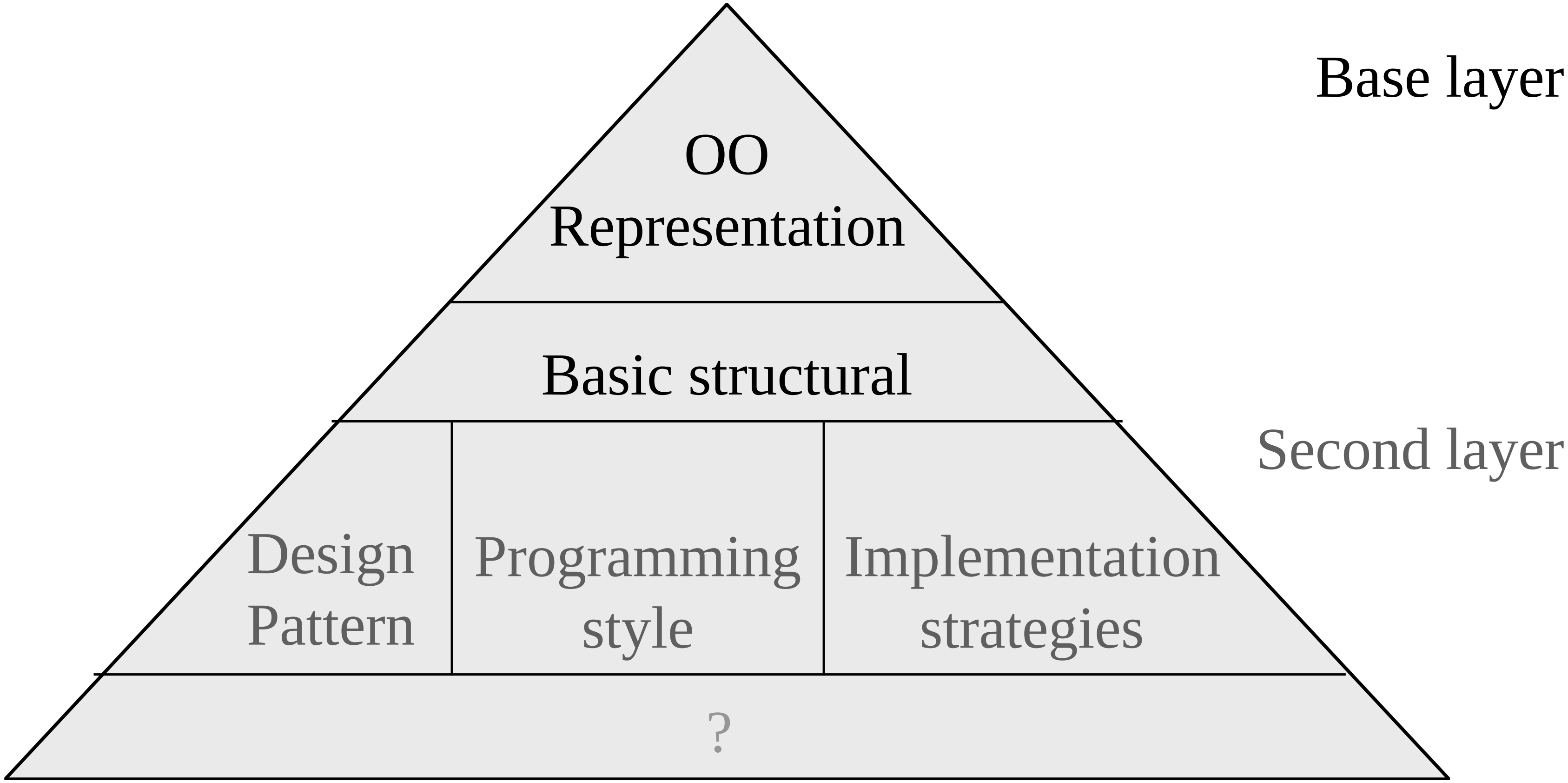
4. SOUL (ctd)

SOUL represents object oriented systems by internal representation of *parsetrees*

⇨ reasoning about implementation on structural level

⇨ code and representation consistent

5. Declarative Framework



Base layer

OO Representation

Basic structural

Second layer

Design Pattern

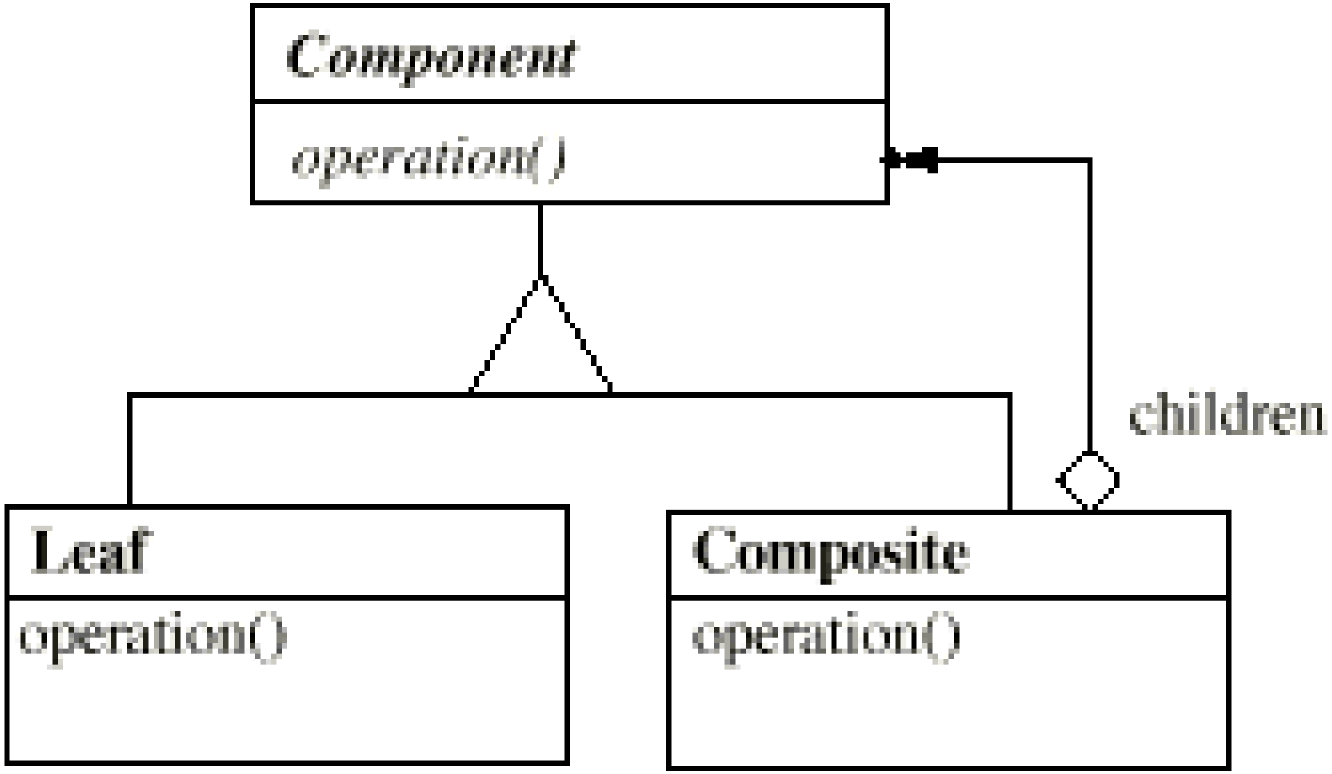
Programming style

Implementation strategies

?

6. Example

Structure of Composite Design Pattern:



6. Example (ctd)

```
Rule compositePattern(?comp,?composite,?op)
if
  compositeStructure(?comp,?composite),
  compositeAggregation(?comp,?composite,?op).

Rule compositeStructure(?comp,?composite)
if
  class(?comp),
  hierarchy(?comp,?composite).
```

6. Example (ctd)

```
Rule
  compositeAggregation(?comp,?composite,?op)
if
  commonSelectors(?comp,?composite,?op),
  methodInClass(?composite,?m,?op),
  parseTree(?m,?tree),
  oneToManyStatement(?tree,?iv,?enumStat),
  isSend(?msg,?enumStat)
```

7. Future Work

- Extend declarative framework
- Support other OO language (Java)
- Investigate MLI
- Generate code (structural find/replace)
- Build more Tools

8. Conclusion

- Open, explicit, general system is needed to reason about the structure of OO systems
- Standalone Prolog is not enough
- We proposed SOUL, a logic meta-language, that addresses some Prolog Problems
- the declarative framework: to express and reason about the structure in a base-language independent way.

Coordinates

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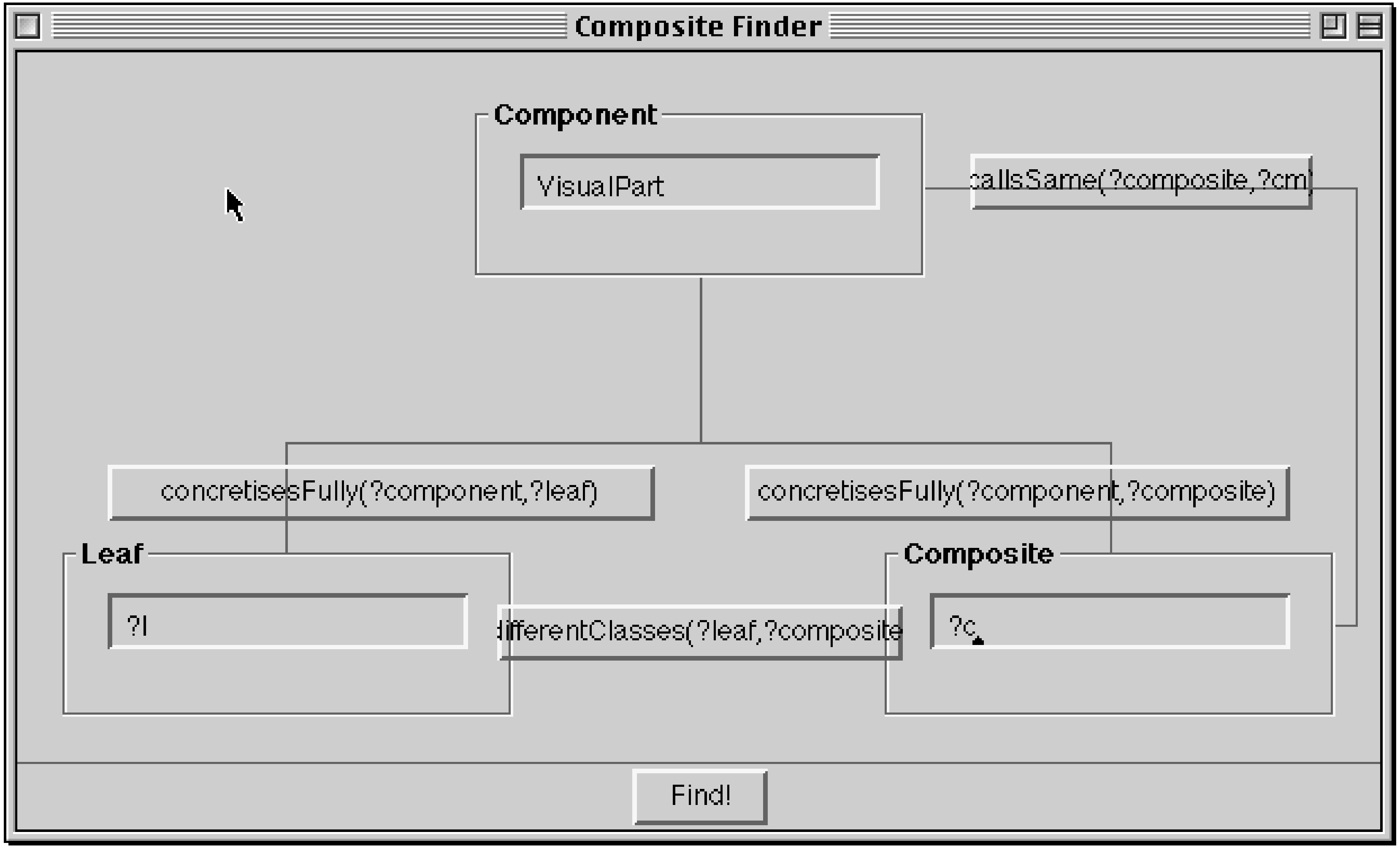
6. Example (ctd)



Component: VisualPart

callsSame(?composite,?cm

concretisesFully(?component,?leaf)

concretisesFully(?component,?composite)

Leaf: ?l

ifferentClasses(?leaf,?composite

Composite: ?c