Intentional source-code views

Kim Mens
(U. Catholique Louvain-la-Neuve)
Tom Mens
(Vrije U. Brussel)
Michel Wermelinger
(LabMAC – U. Lisboa)

Problem

- Software evolution and maintenance are hard
  - "Information overload"
    - Difficult to understand and browse *large* software systems
    - When something breaks upon evolution, it is difficult to find out *what*, *where* and *why*
  - Insufficient support for managing *crosscutting concerns*
    - "Tyranny of the dominant decomposition"
  - "Intentions" of developers are not documented
    - Difficult to understand relevant concerns, assumptions, intentions, conventions, constraints
    - Hidden or implicit in source code or in heads of developers
    - Should be codified explicitly, e.g., to detect potential inconsistencies and evolution conflicts

Solution

- Intentional source-code views
  - Views may crosscut the implementation decomposition
  - Relations among these views
  - Explicitly codify important concerns, assumptions, intentions and conventions …
  - … that can be verified upon evolution
  - Manage structural and semantic inconsistencies

Source-code views

- A source-code view
  - Is a set of source-code entities that address a same concern
  - One view can contain many entities
  - Views may crosscut dominant implementation decomposition
- A source-code entity
  - Can be any tangible language construct: method, class, variable
  - One source-code entity can reside in multiple source-code views
- Views can be defined
  - Extensionally = by explicit enumeration of their elements
  - Intentionally = by declaratively describing their elements
  - One view can have multiple (mutually consistent) definitions
- Kinds of views
  - Predefined by language/environment ; Extracted by tools; User-defined

Examples of source-code views

- **Logic predicates**
  - All predefined logic predicates in SOUL
- Alternative definitions:
  1) Everything stored in one of the subclasses of class *LogicRoot*
  2) Everything in a class belonging to a category named '*Soul-Logic*'*
  3) Explicit enumeration of all relevant classes

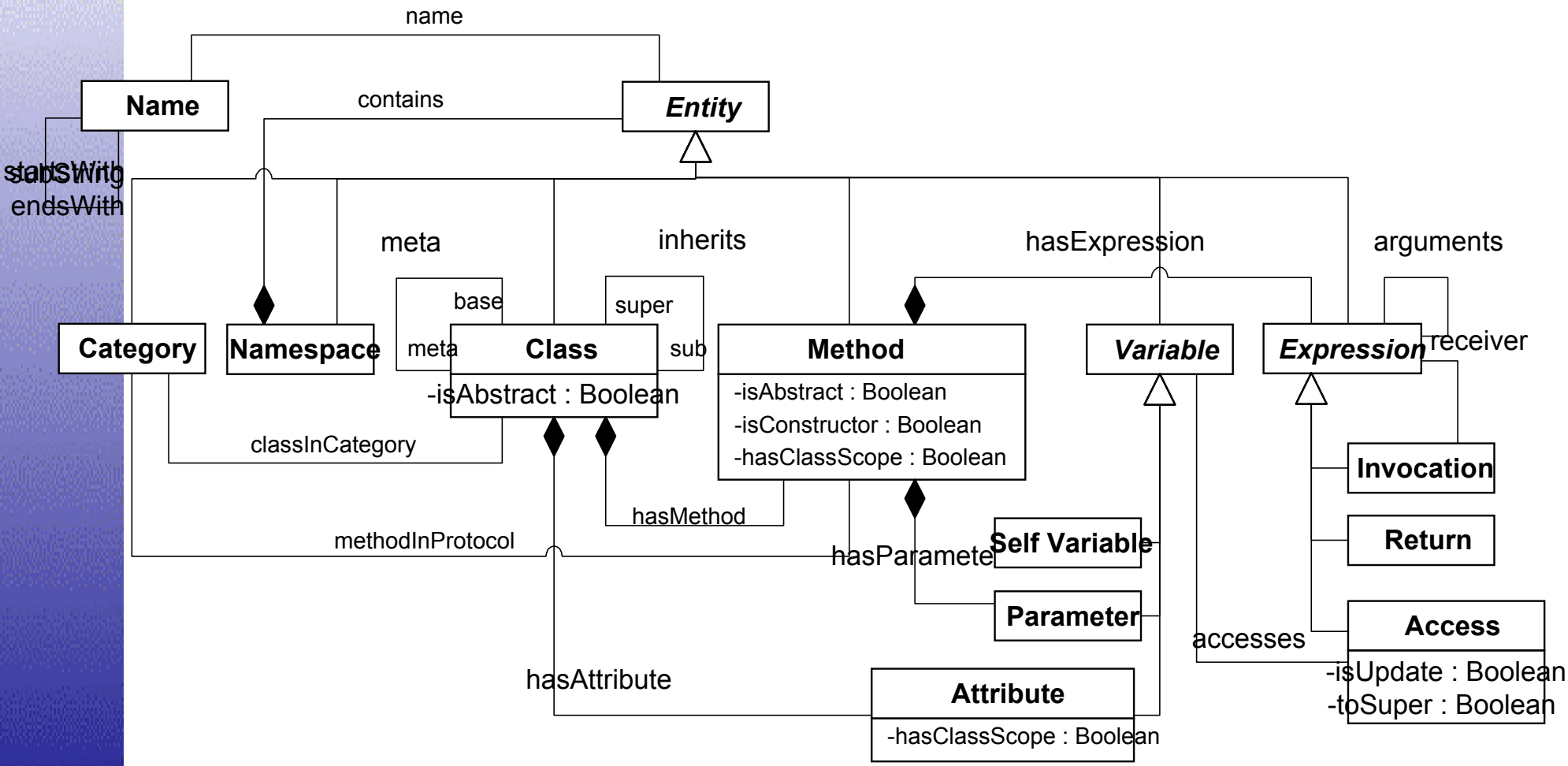
- **Test suites**
  - All methods for testing the SOUL implementation and predicates
- Alternative definitions:
  1) Every method implemented by a subclass of class *LogicTests*
  2) Everything in a class belonging to a category named '**Test*'
  3) Explicit enumeration of all relevant classes

Case study: SOUL, a logic interpreter implemented in VW Smalltalk

Intentional view model

- Intentional views are source-code views that
  - Describe how to compute their elements
  - Are declared as logic predicates over the implementation
    - expressive, readable, concise
    - using primitives from *language model*
  - Can be used in multiple ways
    - Generative: which entities belong to view?
    - Verificative: does entity belong to this view?
  - Can have alternative definitions
    - All definitions should have the same “extension”
    - This codifies implicit constraints on the elements of a view
    - Can be used to detect evolution conflicts

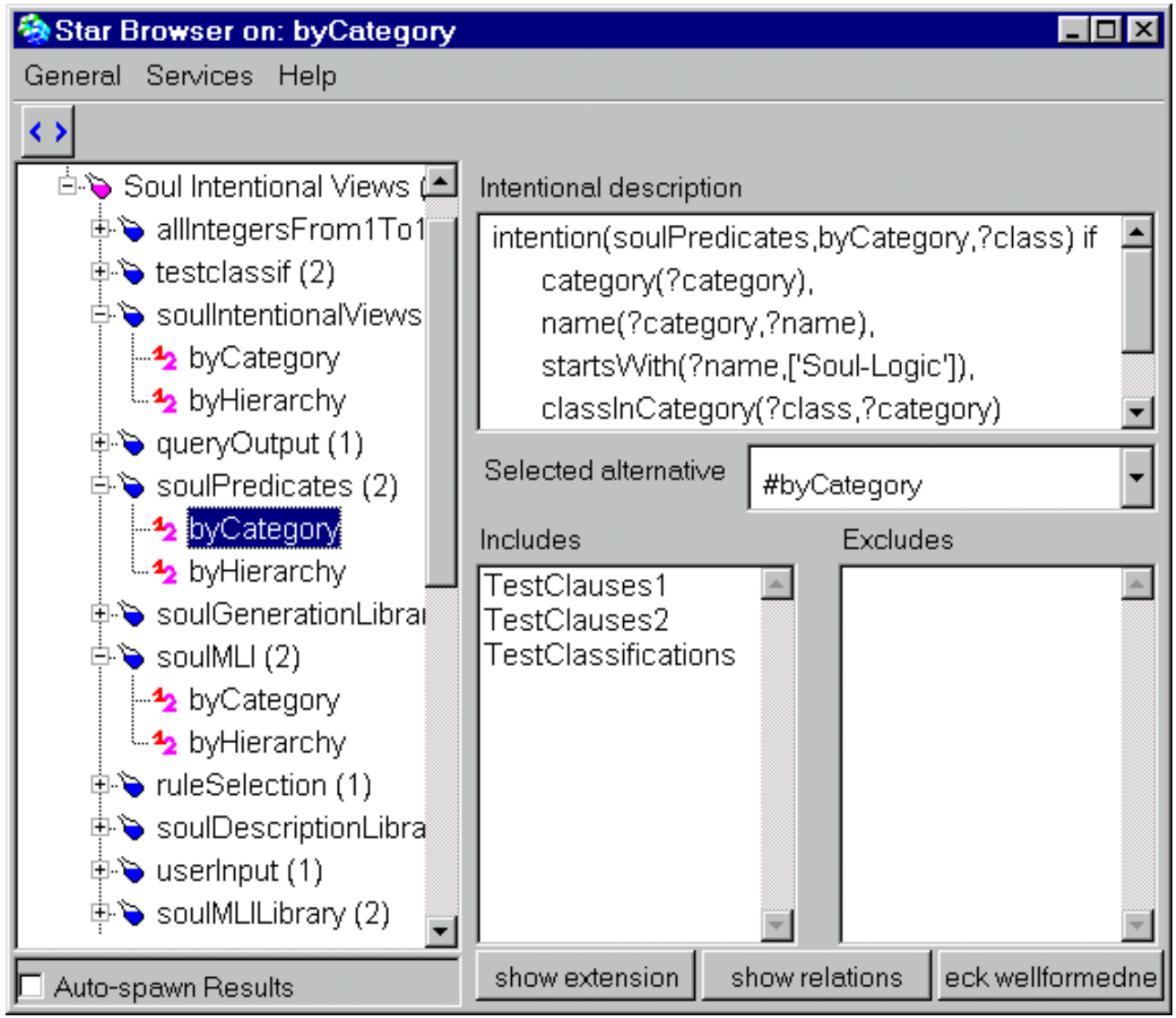
Language model



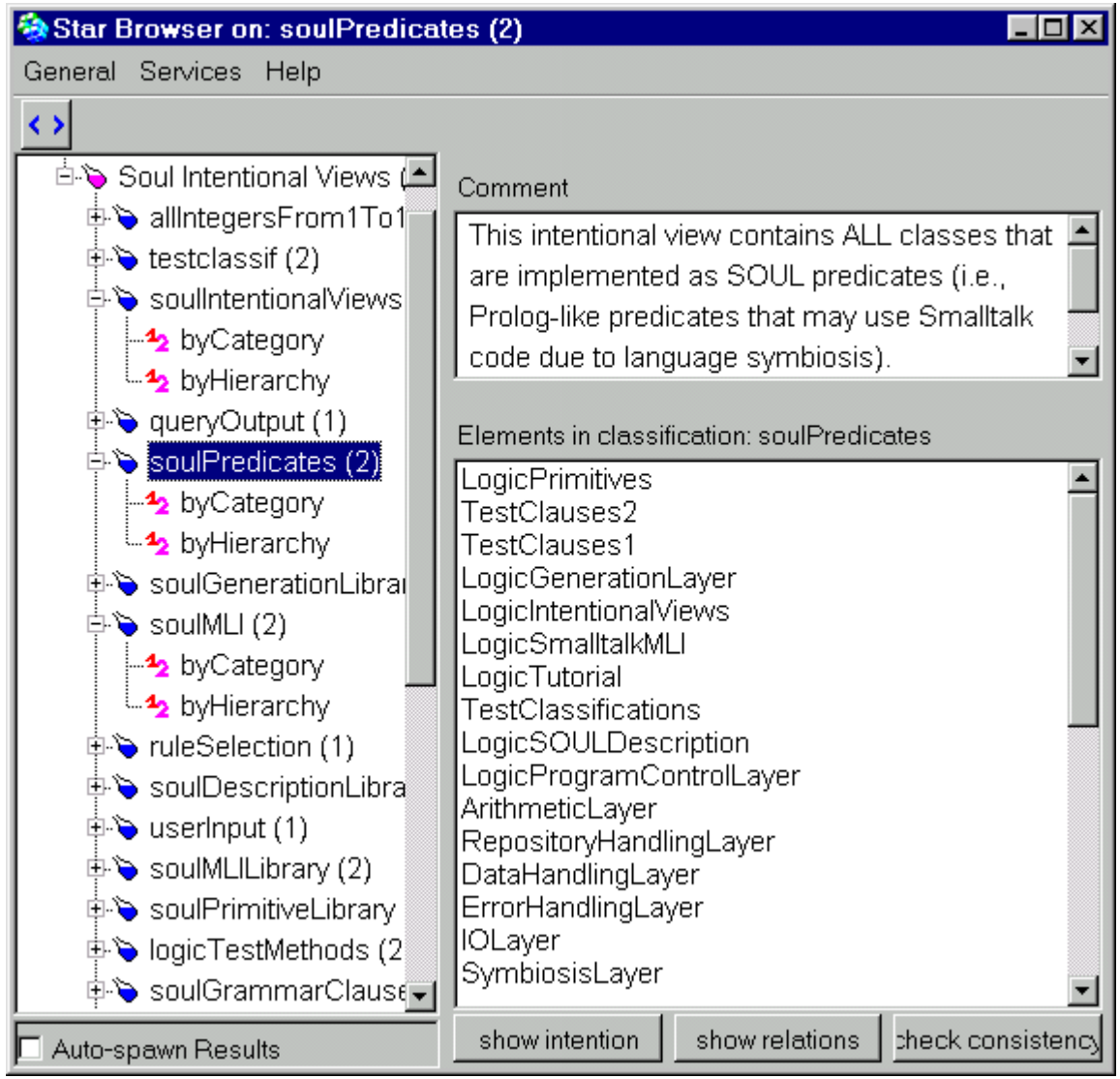
Example: soulPredicates

```
view(soulPredicates,<byCategory,byHierarchy>).
viewComment(soulPredicates,
  ['This intentional view contains ALL classes that implement SOUL predicates (i.e., Prolog-like
    predicates that may use Smalltalk code due to language symbiosis).']).
default(soulPredicates,byCategory).

intention(soulPredicates,byCategory,?class) if
            category(?category),
            name(?category,?name),
            startsWith(?name,['Soul-Logic']),
            classInCategory(?class,?category).
include(soulPredicates,byCategory,[Soul.SoulTests.TestClauses1]).
include(soulPredicates,byCategory,[Soul.SoulTests.TestClauses2]).
include(soulPredicates,byCategory,[Soul.SoulTests.TestClassifications]).

intention(soulPredicates,byHierarchy,?class) if
            …
```

Intention Viewer

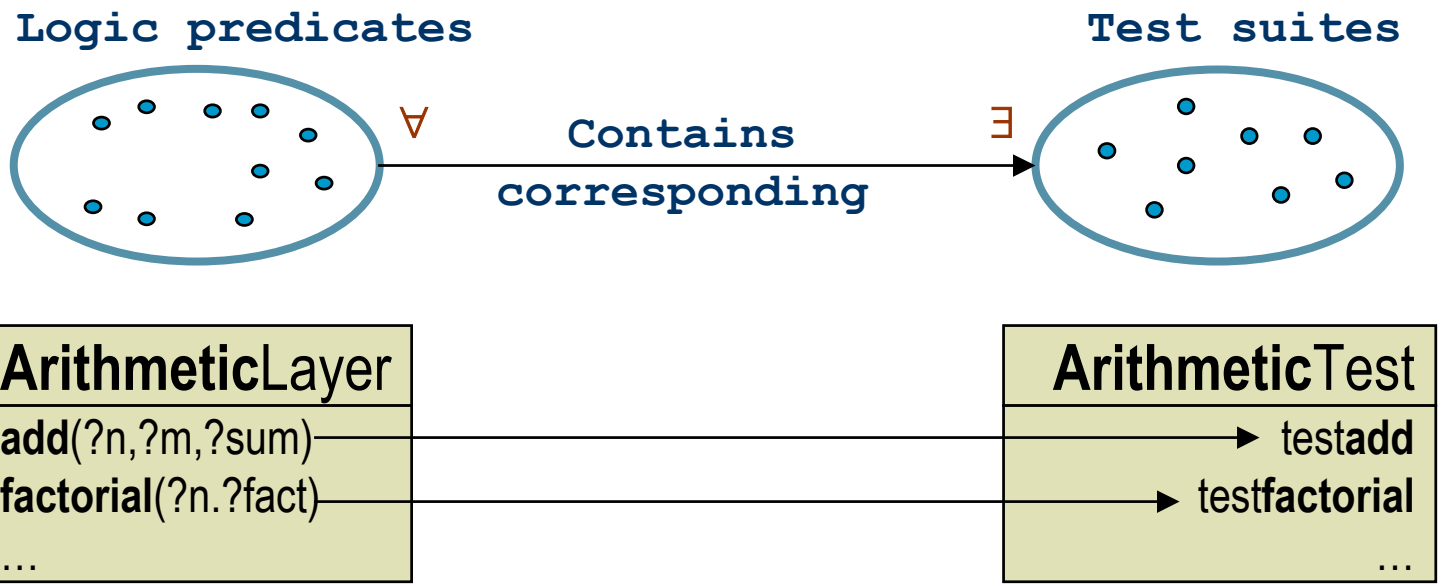


Extension Editor



Example of relations among views

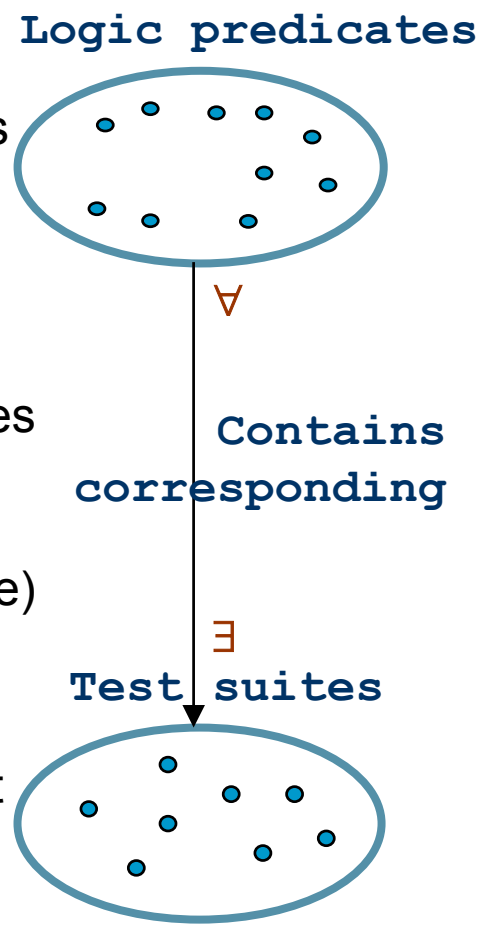
- **Logic predicates**
  - All predefined logic predicates in SOUL
- **Test suites**
  - All methods for testing the SOUL implementation and predicates



Example: Test-suite completeness of SOUL

Relations among intentional views

- Relations
  - Describe important relationships among the elements of source-code views
  - Are declared as logic predicates over source-code views
    - expressive, readable, concise
  - Often simply as a predicate r over source-code entities and a set quantifier (∀, ∃) to map it over the views
    - $A\ r\ B \Leftrightarrow \forall\ a \in A : \exists\ b \in B : a\ r\ b$
  - Can be used in multiple ways (verificative / generative)
  - Can be used to detect interesting *evolution conflicts*
- Example: test suite completeness
  - Every logic predicate must have a corresponding test method



Generating code

- Test-suite completeness
  - Every logic predicate must have a corresponding test method
- “Untested predicates” view
  - Contains all predicates that have no corresponding test method
  - Test-suite is complete if this view is empty
- Default test methods
  - Can be generated automatically for all predicates in this view
    - So that we have no untested predicates anymore
  - Default test methods always fail
    - So that developer is “forced” to test them

Contributions

- A logic meta-programming environment for
  - active and enforceable documentation of object-oriented source-code
- A model for intentional source-code views
  - language-independent
  - cross-cutting modularisation of implementation entities
  - intuitive and lightweight
  - verifiable declarations
  - codify intentions in software engineers' heads

Contributions (2)

- A proof-of-concept prototype tool
  - adding/removing/modifying views and relations
  - detecting inconsistencies and evolution conflicts
    - When alternative definitions are inconsistent
    - When relations among views become invalid
  - advanced browsing and structuring of source-code
  - code generation
- Validated on a real-world case study
  - ongoing evolution of SOUL
  - little overhead, effort pays off (?)

Intentional source-code views as architectural abstractions