# Intensional source-code Views and Relations

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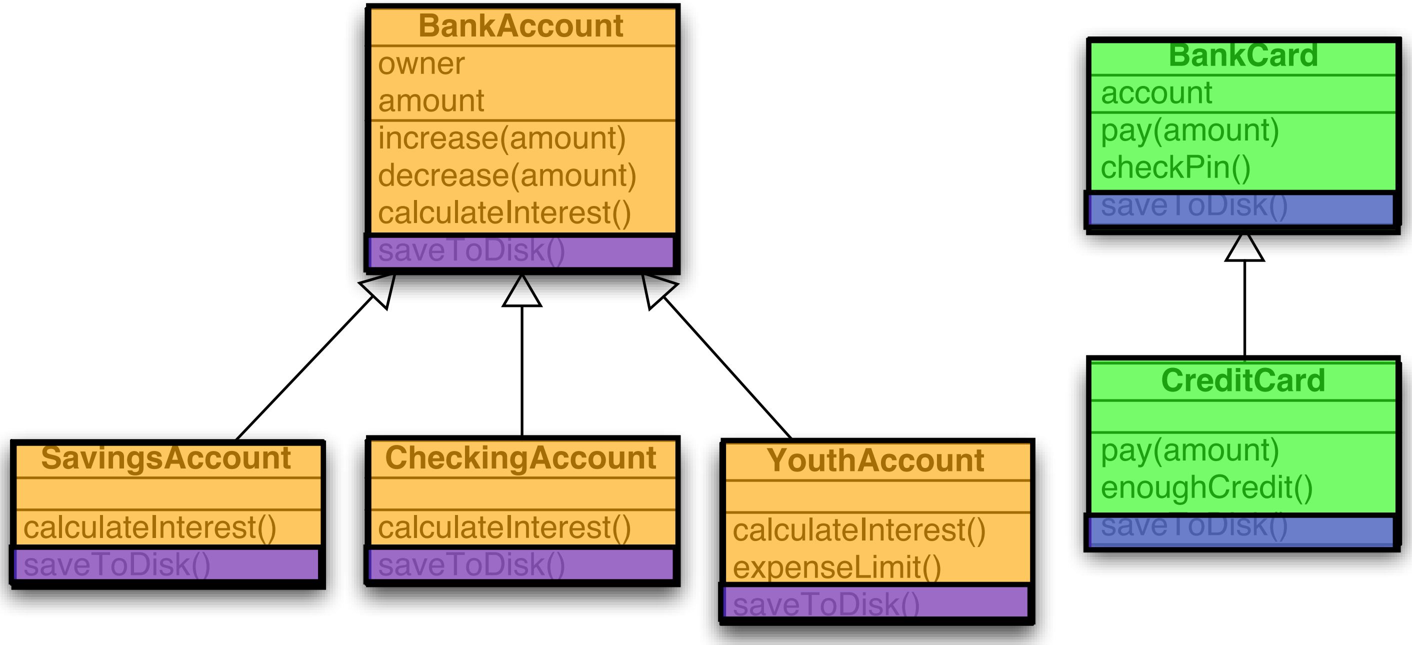
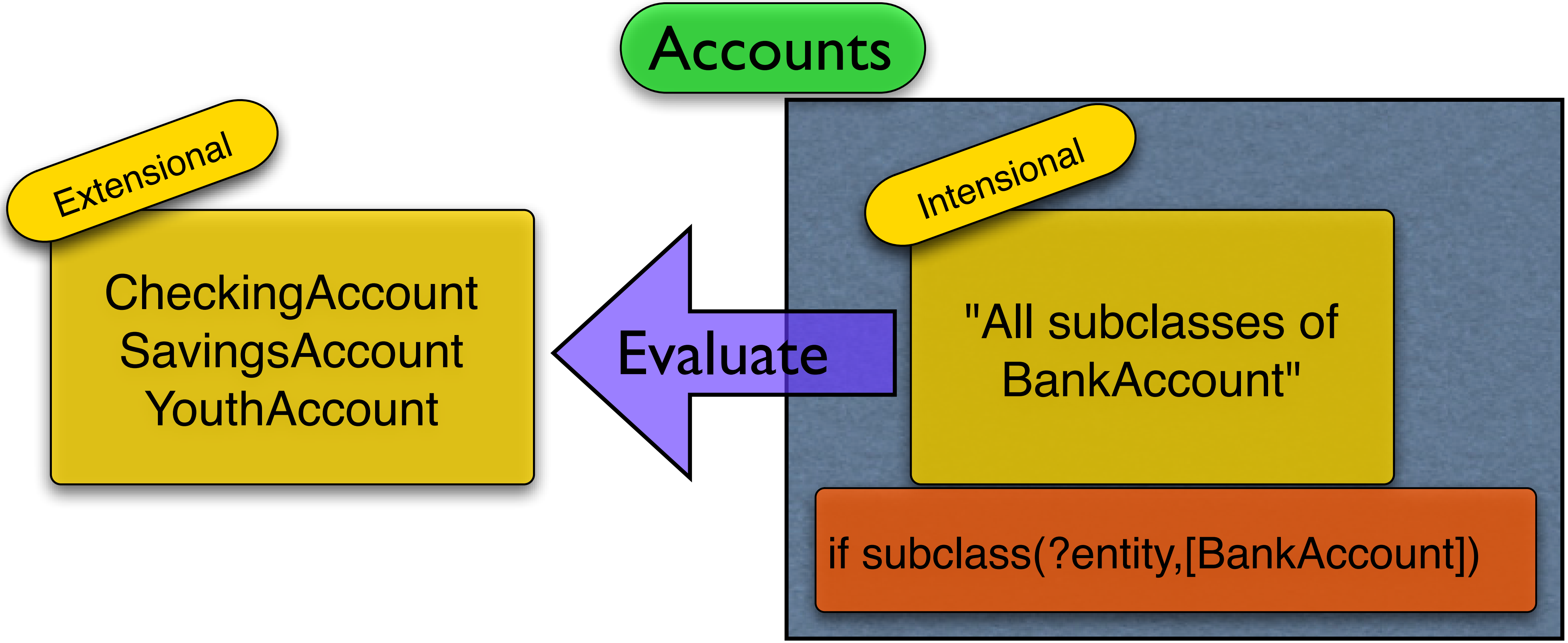
# Source-code Documentation



Source-code View

Collection of source-code entities

# Extensional vs Intensional



Accounts

Extensional

CheckingAccount
SavingsAccount
YouthAccount

Evaluate

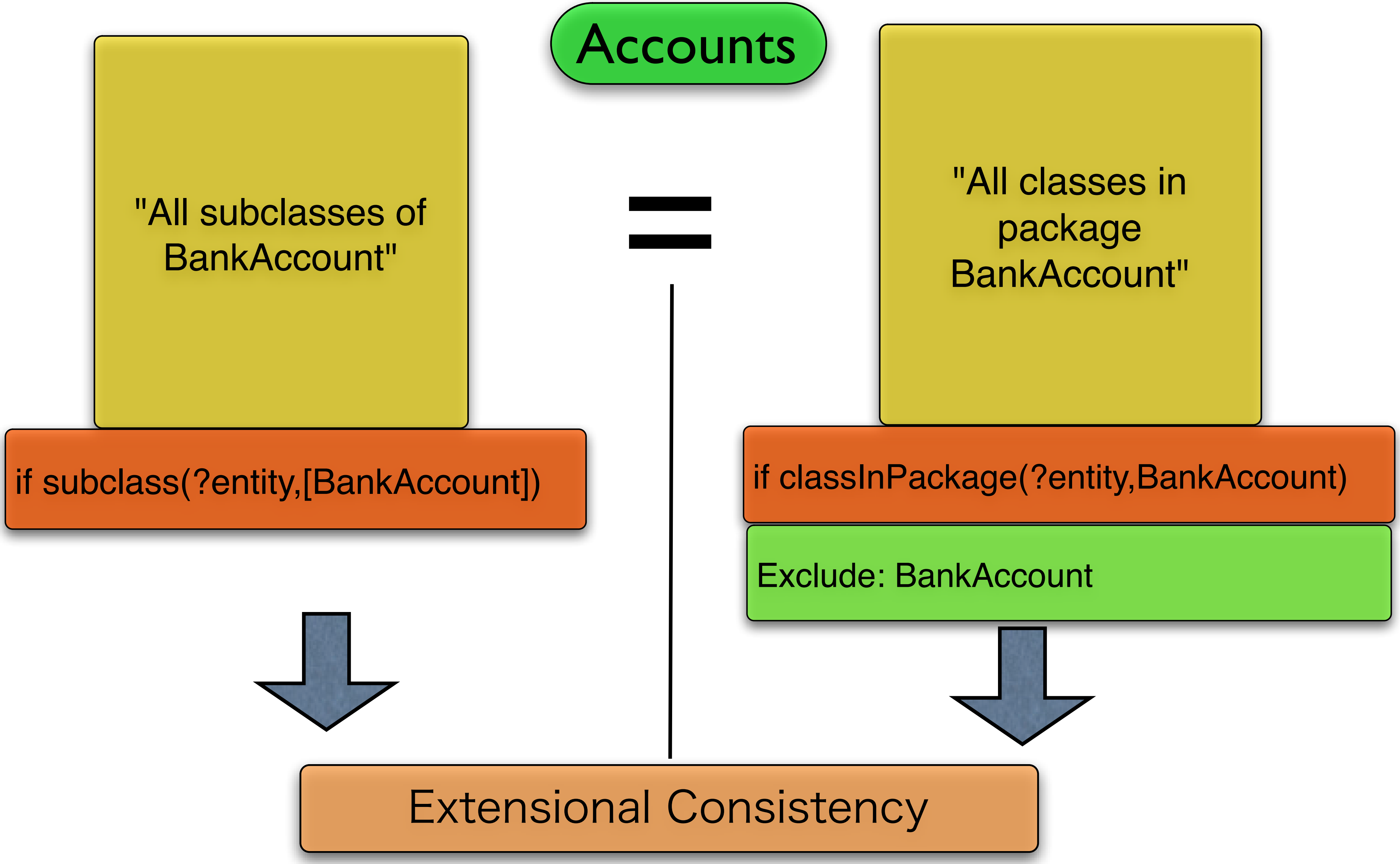
Intensional

"All subclasses of BankAccount"

if subclass(?entity,[BankAccount])

Intensional View

# Intensional Views: alternatives



Accounts

"All subclasses of BankAccount"

if subclass(?entity,[BankAccount])

=

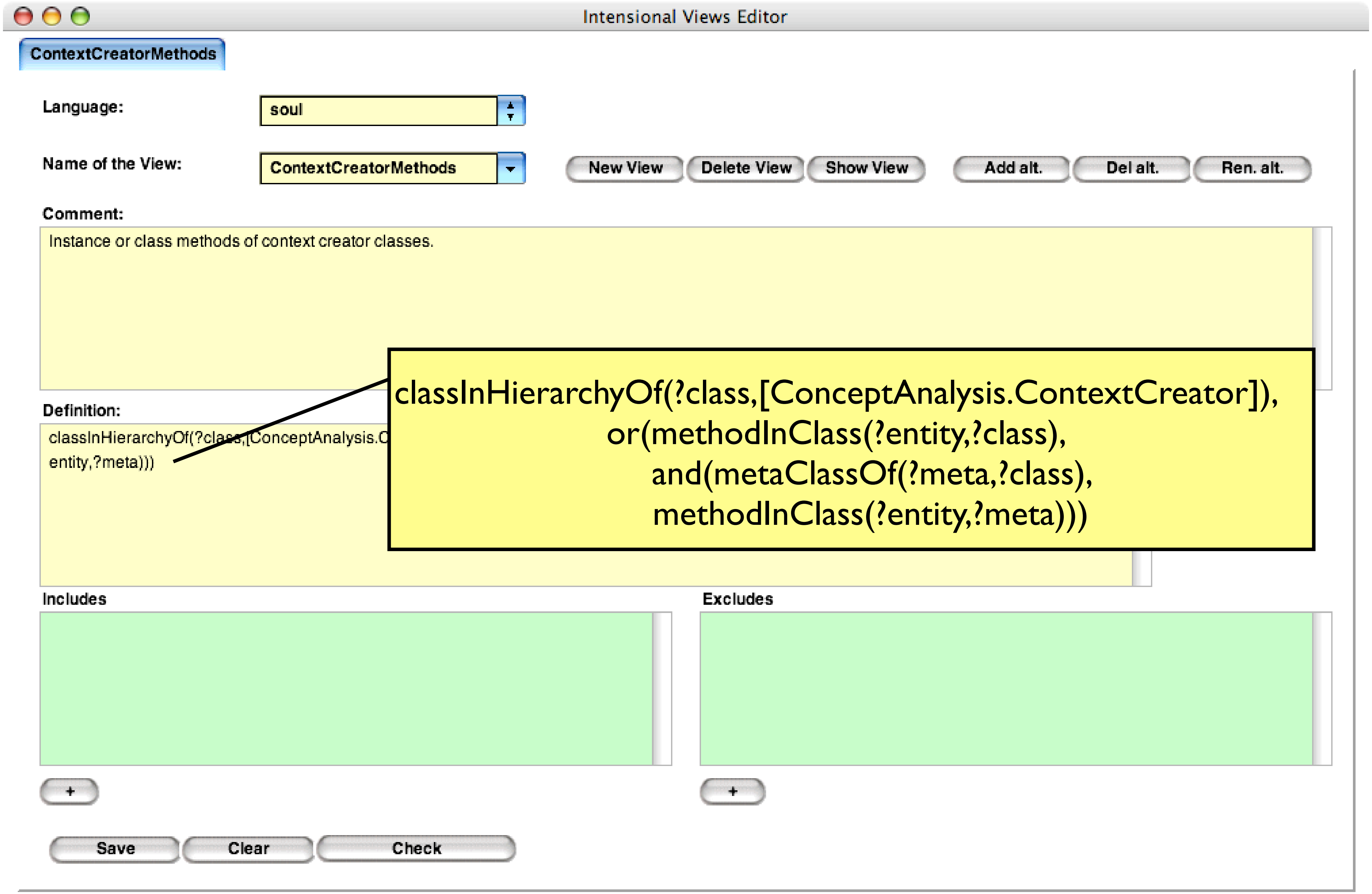
"All classes in package BankAccount"

if classInPackage(?entity,BankAccount)

Exclude: BankAccount

Extensional Consistency

# Intensional View Browser



Language: soul

Name of the View: ContextCreatorMethods

Comment:

Instance or class methods of context creator classes.

Definition:

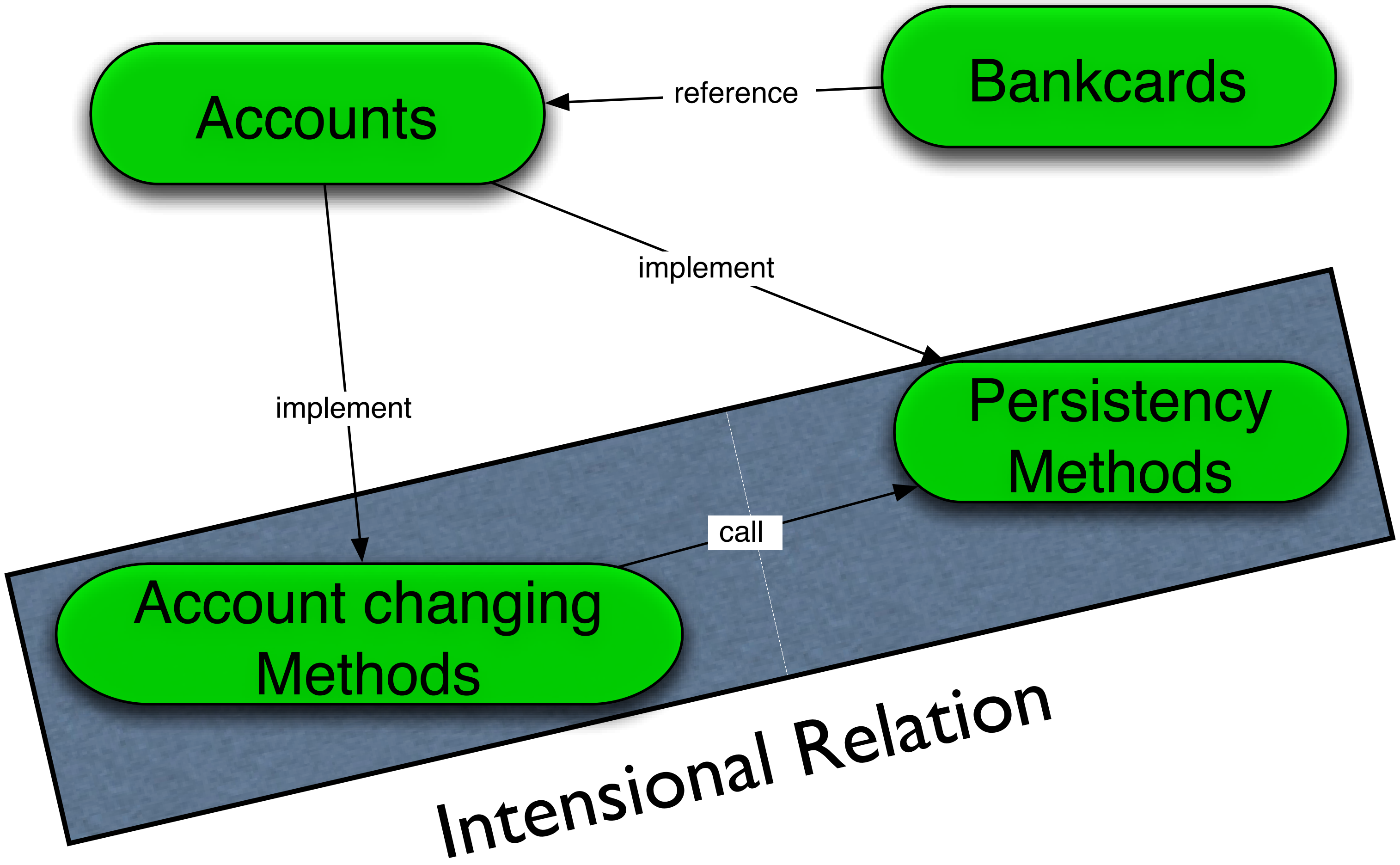
```
classInHierarchyOf(?class,[ConceptAnalysis.C
entity,?meta)))
```

Includes

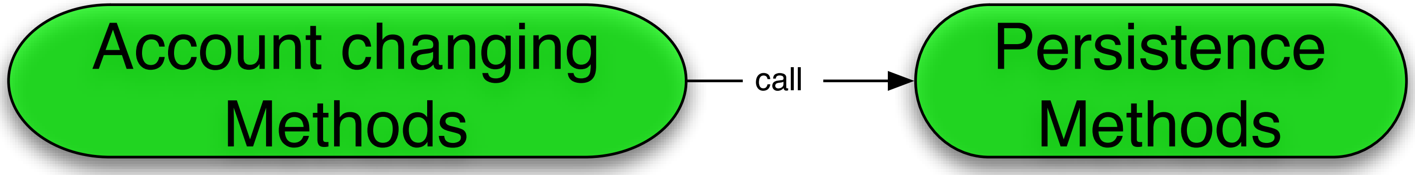
Excludes

```
classInHierarchyOf(?class,[ConceptAnalysis.ContextCreator]),
       or(methodInClass(?entity,?class),
          and(metaClassOf(?meta,?class),
          methodInClass(?entity,?meta)))
```

# Intensional Relations



# Intensional Relations



Account changing Methods

call

Persistence Methods

All account changing methods must call a persistence method

$\forall$ x $\in$ "Account changing methods"
$\exists$ y $\in$ "Persistence Methods"
x calls y

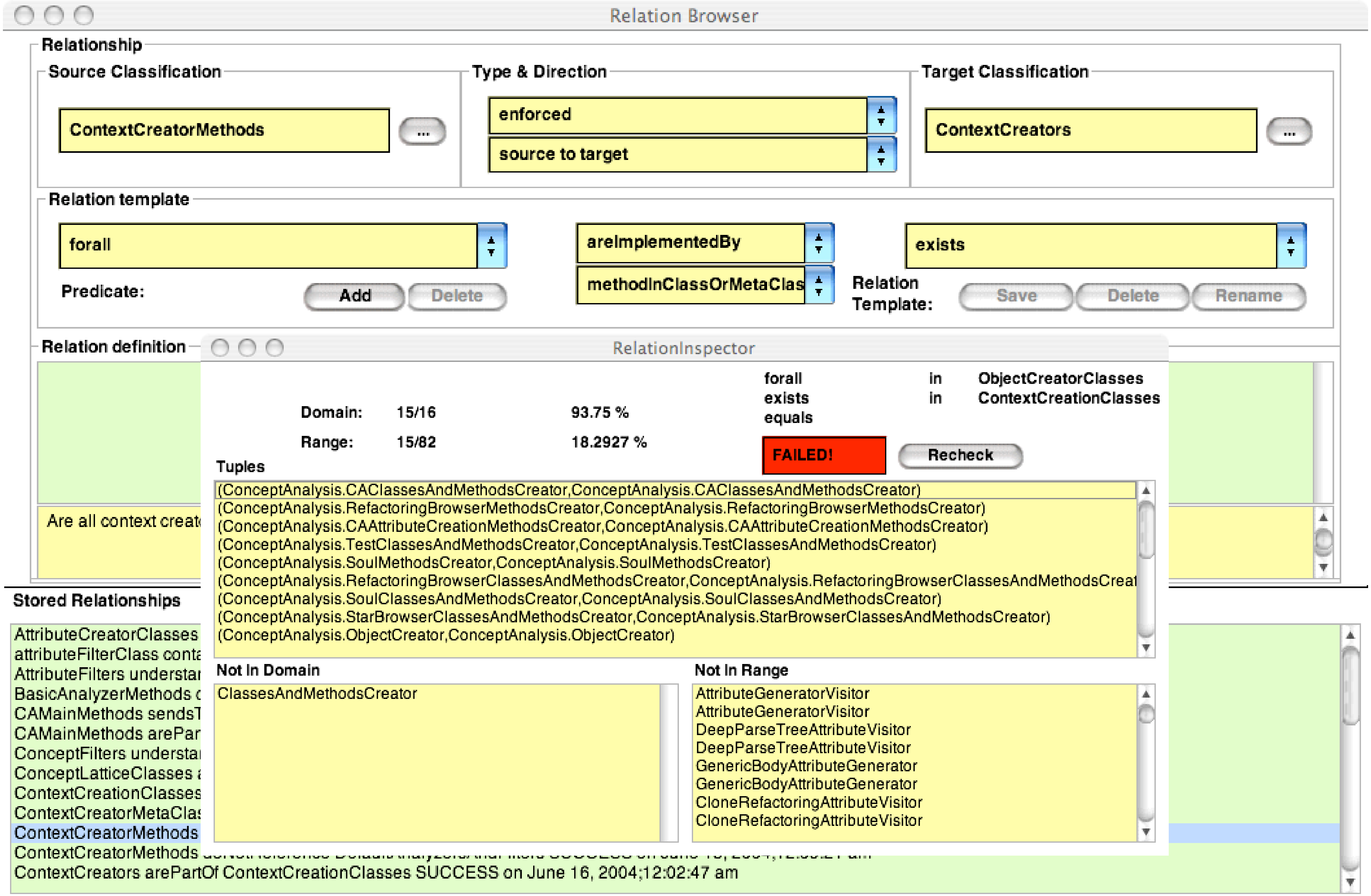
$Q_1\ x \in V_1;\ Q_2\ y \in V2:\ x\ r\ y$

$Q_1, Q_2 \in \{\forall, \exists, \nexists, \exists!, \ldots\}$

$V_1, V_2 \in$ Views

r = predicate over source-code entities

# Relation Browser & Inspector



Source Classification: ContextCreatorMethods

Type & Direction: enforced

source to target

Target Classification: ContextCreators

Relation template: forall | areImplementedBy | exists

methodInClassOrMetaClas

Predicate:

Relation Template:

Are all context creat

| | | | forall | in | ObjectCreatorClasses |
|---|---|---|---|---|---|
| | | | exists | in | ContextCreationClasses |
| Domain: | 15/16 | 93.75 % | equals | | |
| Range: | 15/82 | 18.2927 % | FAILED! | | |

Tuples

```
(ConceptAnalysis.CAClassesAndMethodsCreator,ConceptAnalysis.CAClassesAndMethodsCreator)
(ConceptAnalysis.RefactoringBrowserMethodsCreator,ConceptAnalysis.RefactoringBrowserMethodsCreator)
(ConceptAnalysis.CAAttributeCreationMethodsCreator,ConceptAnalysis.CAAttributeCreationMethodsCreator)
(ConceptAnalysis.TestClassesAndMethodsCreator,ConceptAnalysis.TestClassesAndMethodsCreator)
(ConceptAnalysis.SoulMethodsCreator,ConceptAnalysis.SoulMethodsCreator)
(ConceptAnalysis.RefactoringBrowserClassesAndMethodsCreator,ConceptAnalysis.RefactoringBrowserClassesAndMethodsCreat
(ConceptAnalysis.SoulClassesAndMethodsCreator,ConceptAnalysis.SoulClassesAndMethodsCreator)
(ConceptAnalysis.StarBrowserClassesAndMethodsCreator,ConceptAnalysis.StarBrowserClassesAndMethodsCreator)
(ConceptAnalysis.ObjectCreator,ConceptAnalysis.ObjectCreator)
```

Not In Domain

```
ClassesAndMethodsCreator
```

Not In Range

```
AttributeGeneratorVisitor
AttributeGeneratorVisitor
DeepParseTreeAttributeVisitor
DeepParseTreeAttributeVisitor
GenericBodyAttributeGenerator
GenericBodyAttributeGenerator
CloneRefactoringAttributeVisitor
CloneRefactoringAttributeVisitor
```

Stored Relationships

```
AttributeCreatorClasses
attributeFilterClass conta
AttributeFilters understar
BasicAnalyzerMethods c
CAMainMethods sendsT
CAMainMethods arePar
ConceptFilters understar
ConceptLatticeClasses a
ContextCreationClasses
ContextCreatorMetaClas
ContextCreatorMethods
ContextCreatorMethods doNotReference DefaultAnalyzersAndFilters SUCCESS on June 16, 2004;12:03:21 am
ContextCreators arePartOf ContextCreationClasses SUCCESS on June 16, 2004;12:02:47 am
```

# Deducing Relations

INPUT

Collection of source views

Collection of target views

Set of predicates

∀ and ∃

Approach:

All combinations of views, predicates and quantors

OUTPUT

Set of relations

Redundancy

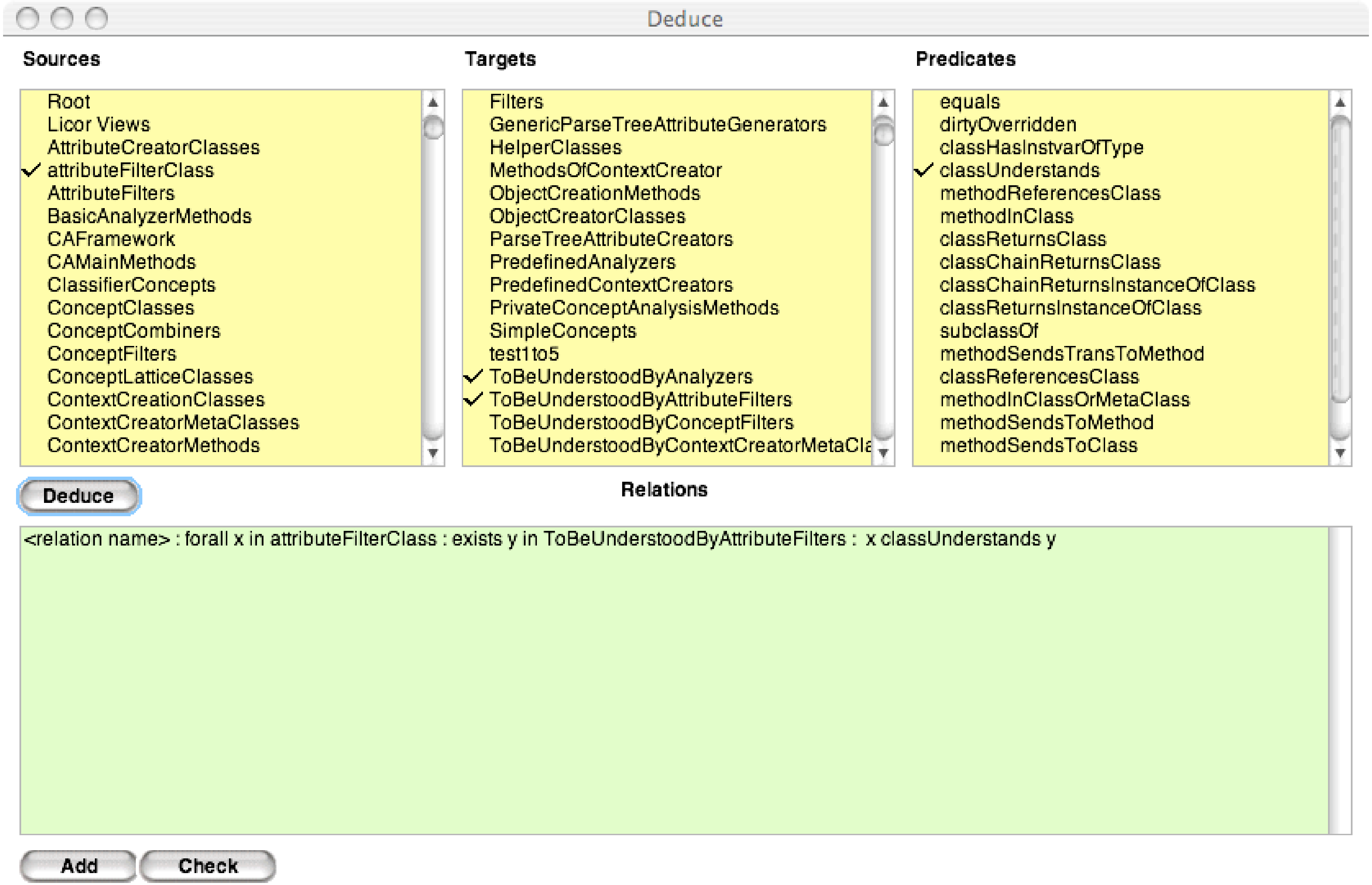
Subset relations

"Weak" Relations

Subsumed Relations

Prune ∃ - ∃ by threshold on min. number of tuples

# Deducing Tool



Sources

- Root
- Licor Views
- AttributeCreatorClasses
- ✓ attributeFilterClass
- AttributeFilters
- BasicAnalyzerMethods
- CAFramework
- CAMainMethods
- ClassifierConcepts
- ConceptClasses
- ConceptCombiners
- ConceptFilters
- ConceptLatticeClasses
- ContextCreationClasses
- ContextCreatorMetaClasses
- ContextCreatorMethods

Targets

- Filters
- GenericParseTreeAttributeGenerators
- HelperClasses
- MethodsOfContextCreator
- ObjectCreationMethods
- ObjectCreatorClasses
- ParseTreeAttributeCreators
- PredefinedAnalyzers
- PredefinedContextCreators
- PrivateConceptAnalysisMethods
- SimpleConcepts
- test1to5
- ✓ ToBeUnderstoodByAnalyzers
- ✓ ToBeUnderstoodByAttributeFilters
- ToBeUnderstoodByConceptFilters
- ToBeUnderstoodByContextCreatorMetaCla

Predicates

- equals
- dirtyOverridden
- classHasInstvarOfType
- ✓ classUnderstands
- methodReferencesClass
- methodInClass
- classReturnsClass
- classChainReturnsClass
- classChainReturnsInstanceOfClass
- classReturnsInstanceOfClass
- subclassOf
- methodSendsTransToMethod
- classReferencesClass
- methodInClassOrMetaClass
- methodSendsToMethod
- methodSendsToClass

```
<relation name> : forall x in attributeFilterClass : exists y in ToBeUnderstoodByAttributeFilters :  x classUnderstands y
```

# Experiment: framework documentation

Case study: DelfStoF framework

- Initial Understanding

Encode assumptions using views and relations

- Verification and refinement

Verify assumptions with code; refine where necessary

- Deducing new relations

Deduce new relations

- Co-evolution

Apply documentation to newer versions

# Initial Understanding

Encode assumptions using views and relations

- Manually try to understand the framework
- Encode initial assumptions
  - 34 Views
  - 30 Relations

Framework Interface

All classes in view A must implement all selectors in view B

Restrictions

No element of View A may refer an element of View B

# Verification and refinement

Verify assumptions with code; refine where necessary

- Inconsistencies: code - documentation
- Fix inconsistencies:
  - Assumptions were wrong
    - ▷ Refine documentation
  - Assumptions right; code inconsistent
    - ▷ Update/refactor code

FAILED!!!

All elements of view A must call a method from view B

# Deducing new relations

Deduce new relations

- Given:
  - 30 views
  - 15 predicates
- Deduced: 2335 relations
  - 90% automatic pruned
  - +/- 200 relations remained
    - ▷ 17 non-trivial

Need for optimization

# Co-evolution

Apply documentation to newer versions

- Use documentation with newer versions
- Find and fix inconsistencies
  - Update documentation
  - Update implementation

Extensions done by master student

Relations concerning coding conventions broken

Bigger cases needed!

# IVs as Active Documentation

- ➕ Active Documentation
- ➕ Co-evolution between design and implementation
- ➕ Non-intrusive
- ➕ Explicit Formal Documentation
- ➕ Feedback on inconsistencies

- ➖ Manual declaration of Views
- ➖ Efficiency
- ➖ Need for more automation

# Ongoing Work

- Formalism: Description Logics
- Mining of views
  - Formal Concept Analysis
  - Inductive Logic Programming
- Improving deducing of relations
- More and larger case studies

# Questions

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