TECHNISCHE UNIVERSITÄT DRESDEN

**TU Dresden** Department of Computer Science, Software Technology Group

# Static Source Code Analysis using OCL

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# Outline

- **Motivation**
- Prerequisites
  - Metamodeling textual languages
- Source code analysis
- Approach to solution
  - The RestrictEd Plugin
  - Examples
  - Conclusion
  - Future work

SemmleCode

# Motivation


Need for automated Tools to analyse programs for:

- Correct behaviour
- Adhere to given coding conventions

Many tools exist to analyse source code, like SemmleCode or Checkstyle, but:

- They are language specific
- Use self defined languages for rule definition

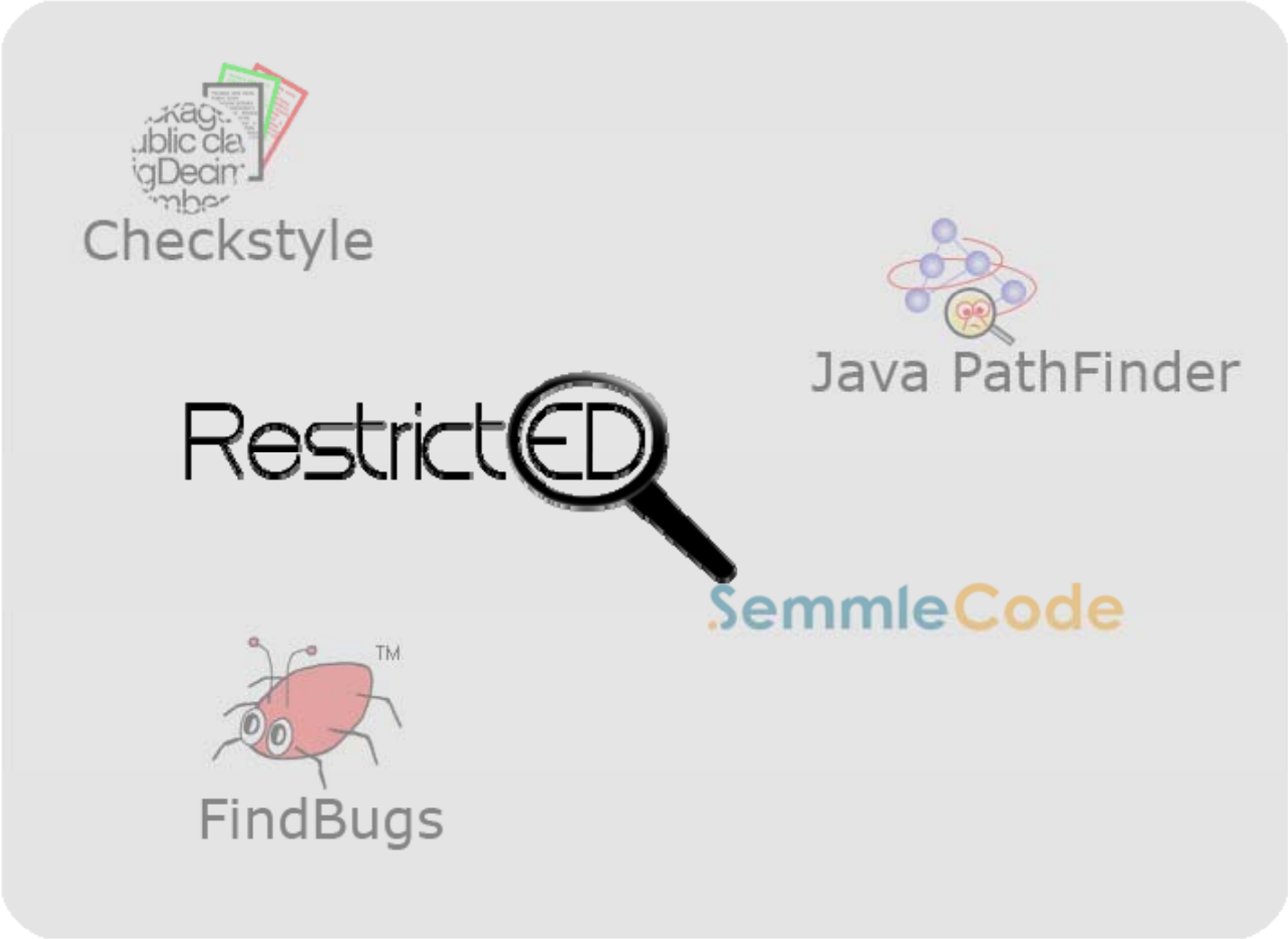
Usage with other or new languages like DSL's not possible

# Motivation

If we could use OCL to define analysis we could:

- Analyse programs for before mentioned problems
- Define rules with a standardized language
- Analyse arbitrary languages with the help of their meta model

# Motivation


Checkstyle
Java PathFinder
RestrictED
SemmleCode
FindBugs

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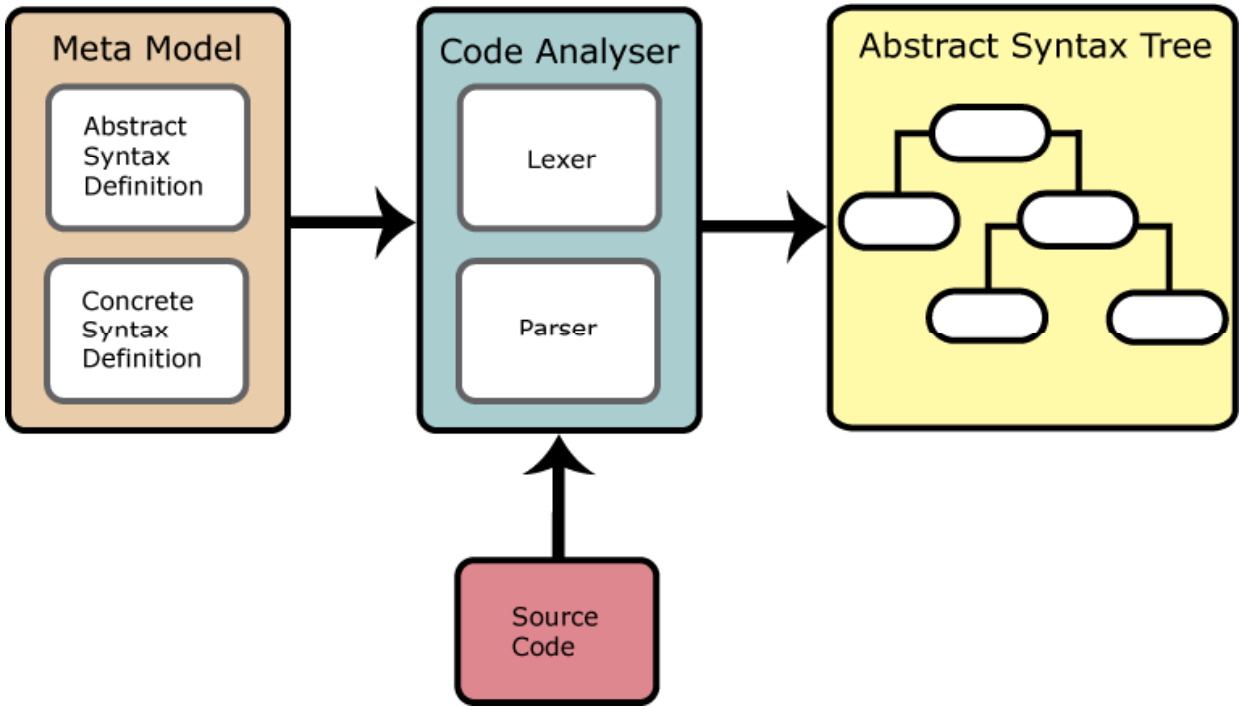
# Metamodeling textual languages – In general

- Traditionally textual languages are “metamodeled” using EBNF
- This allows to generate lexers and parsers
- Editors can use these tools to generate an Abstract Syntax Tree (AST) from the source code
- Correctness of programs can be checked with the help of the AST

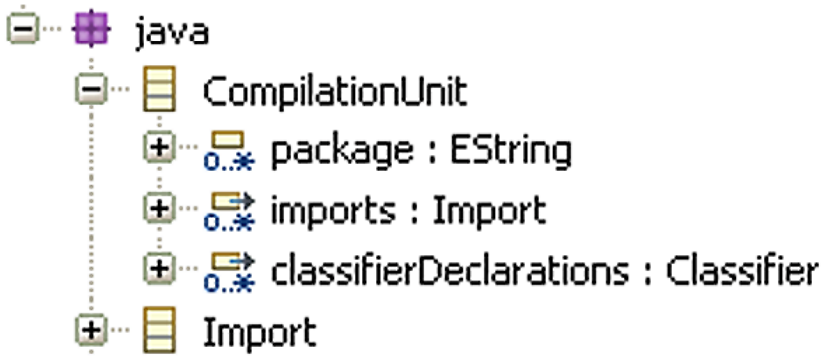


# Metamodeling textual languages – Using EMFText

```
compilationUnit  :  packageDeclaration?
                    importDeclaration*
                    typeDeclaration*;
```

EBNF

ECORE




```
public interface CompilationUnit extends EObject {

   EList<String> getPackage();
   EList<Import> getImports();
   EList<Classifier> getClassifierDeclarations();

}
```

Implementation

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# Source code analysis – When?

Some facts on static source code analysis:

- Some things are checkable at development time
  - Type safety
  - Naming conventions
  - Metrics
- Others can be checked only at runtime

```
public void addMoney(int n){}  // int < 1000 ?
```

# Source code analysis – What?

Language specific constructs can prevent from runtime-errors …

- Const, final
- Visibilities (public, private, protected)

… but they can not prevent program constructs from being changed …

```
public void addMoney(int n, float m){}  // only one Parameter of
   type int!
```

… changing the structure could lead to errors when generated code is involved

# Source code analysis – What?

Coding conventions should be adhered to, e.g. :

- Attributes names should start with an underscore

```
private float _balance;  // OK
private int taxClass;// ERROR
```

- Enforcement of certain metrics like maximum number of methods per class

```
# methods < 15?
```

# Source code analysis – How?

Rules for conventions must be defined.

Question: How can we define rules?

- One could define a new language for querying code like SemmleCode
  -> This leads to language dependence (Java and XML in SemmleCode)

- A standard language like OCL can be used for definition
  -> With the help of meta models this approach leeds to language independence

# Source code analysis – Where?

The rules have to be saved somewhere.

- Internal (within the source code) vs. External (somewhere else)

| | Localization | Language independence |
|---|---|---|
| Internal |  |  |
| External |  |  |

OCL queries provide navigation that must be coded by hand when analysis is performed with standard program code

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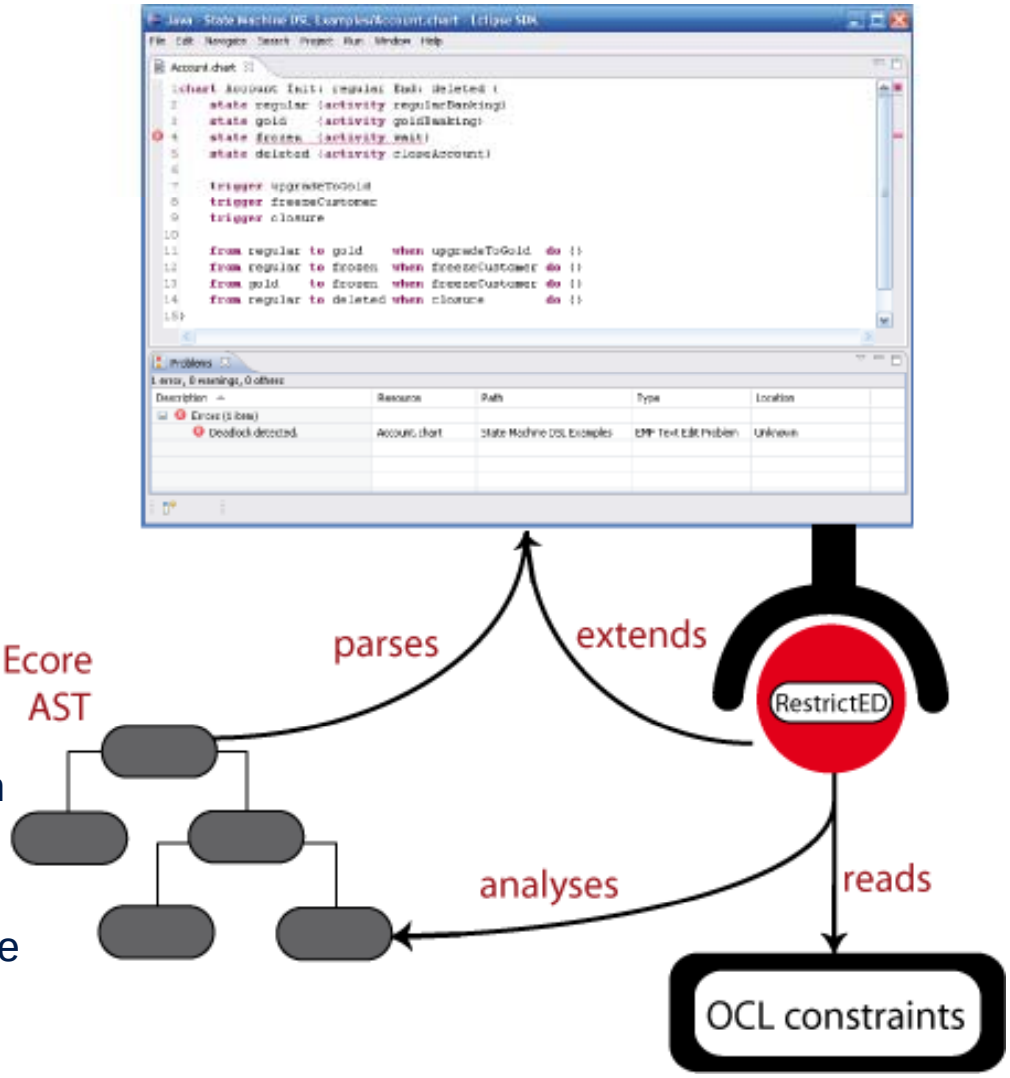
# RestrictEd

- Eclipse-plugin that checks constraints on ecore-models
- Therefore it requires editor with ecore-based AST
- Generation of lexer and parser by Reuseware EMFTextEdit from concrete syntax
- Generation of the meta model from abstract syntax
- Uses OCL as constraint language on meta model
- Each non-empty query result indicates an error in the source code
- Marks and shows errors



# Example SQL

- Some SQL-commands should be prohibited
- Generated code uses table ‘bankaccounts' so deletion should be prevented

```
DROP TABLE bankaccounts;
```

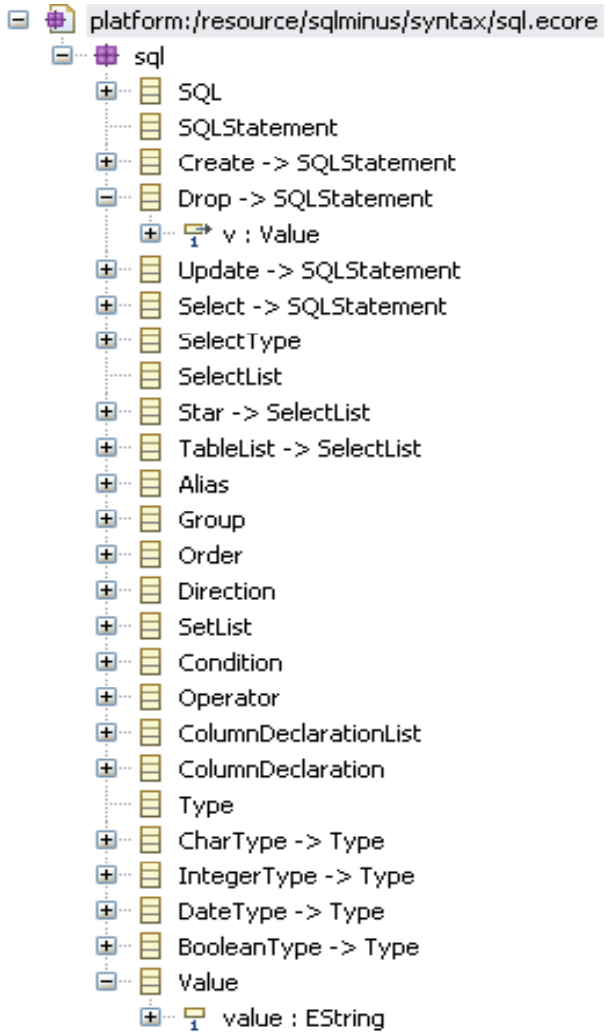
- The owner of a bankaccount must not be altered

```
update accounts set (ownerName='Myself') where value>50000;
```

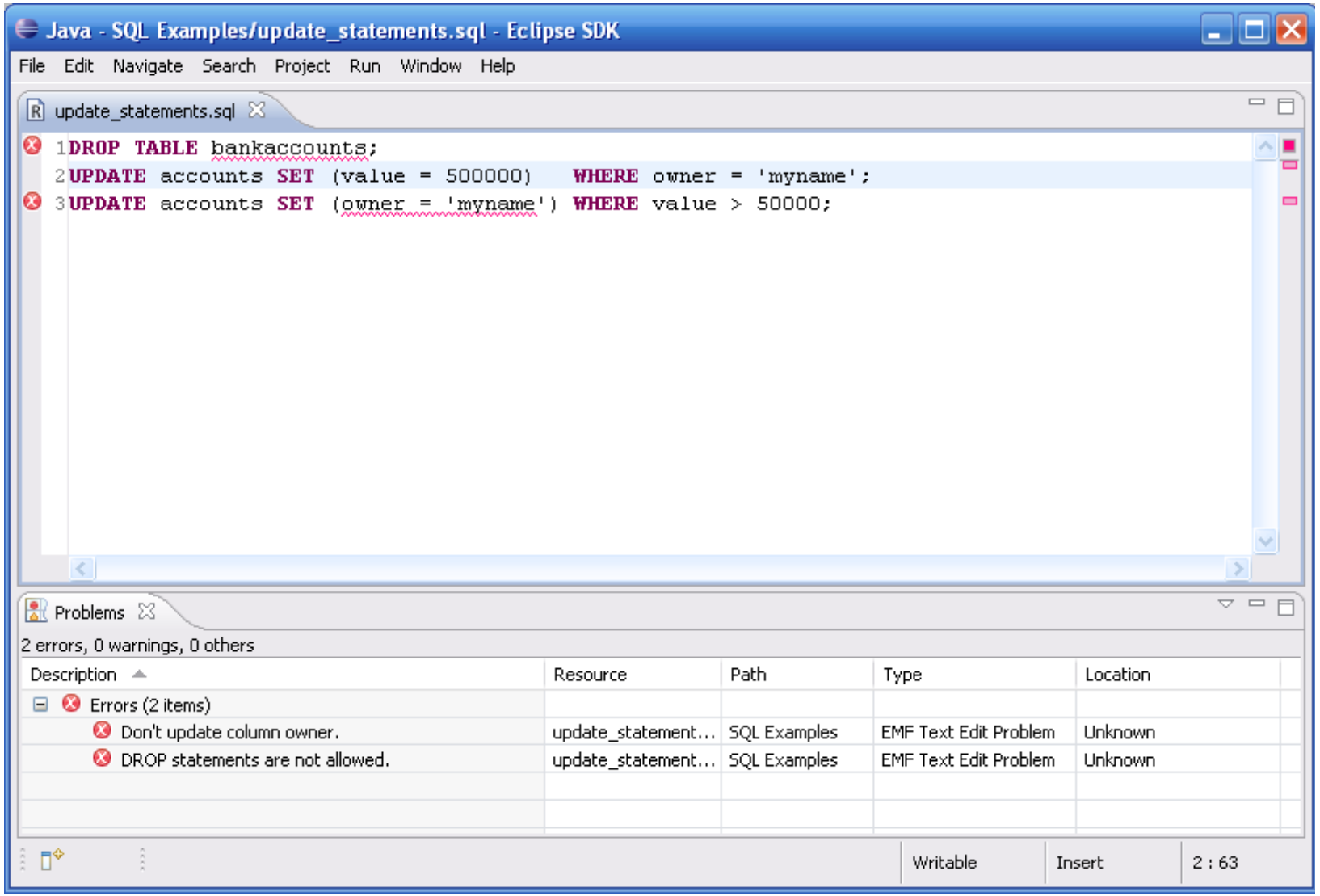
# Example SQL

```
self.sqlStatements->
     select(dp| (dp.oclIsKindOf(Drop)
     and (dp.oclAsType(Drop).v
     .value = 'bankaccount')))

self.sqlStatements->select(us|
   us.oclIsKindOf(Update)).oclAsType(
   Update).list->select(col|
   col.columnName.value = 'owner')
```



# Example SQL


Java - SQL Examples/update_statements.sql - Eclipse SDK
File Edit Navigate Search Project Run Window Help
update_statements.sql
1 DROP TABLE bankaccounts;
2 UPDATE accounts SET (value = 500000) WHERE owner = 'myname';
3 UPDATE accounts SET (owner = 'myname') WHERE value > 50000;
Problems
2 errors, 0 warnings, 0 others
Description
Resource
Path
Type
Location
Errors (2 items)
Don't update column owner.
update_statement...
SQL Examples
EMF Text Edit Problem
Unknown
DROP statements are not allowed.
update_statement...
SQL Examples
EMF Text Edit Problem
Unknown
Writable
Insert
2 : 63

# Example Java

Examples for restrictions:

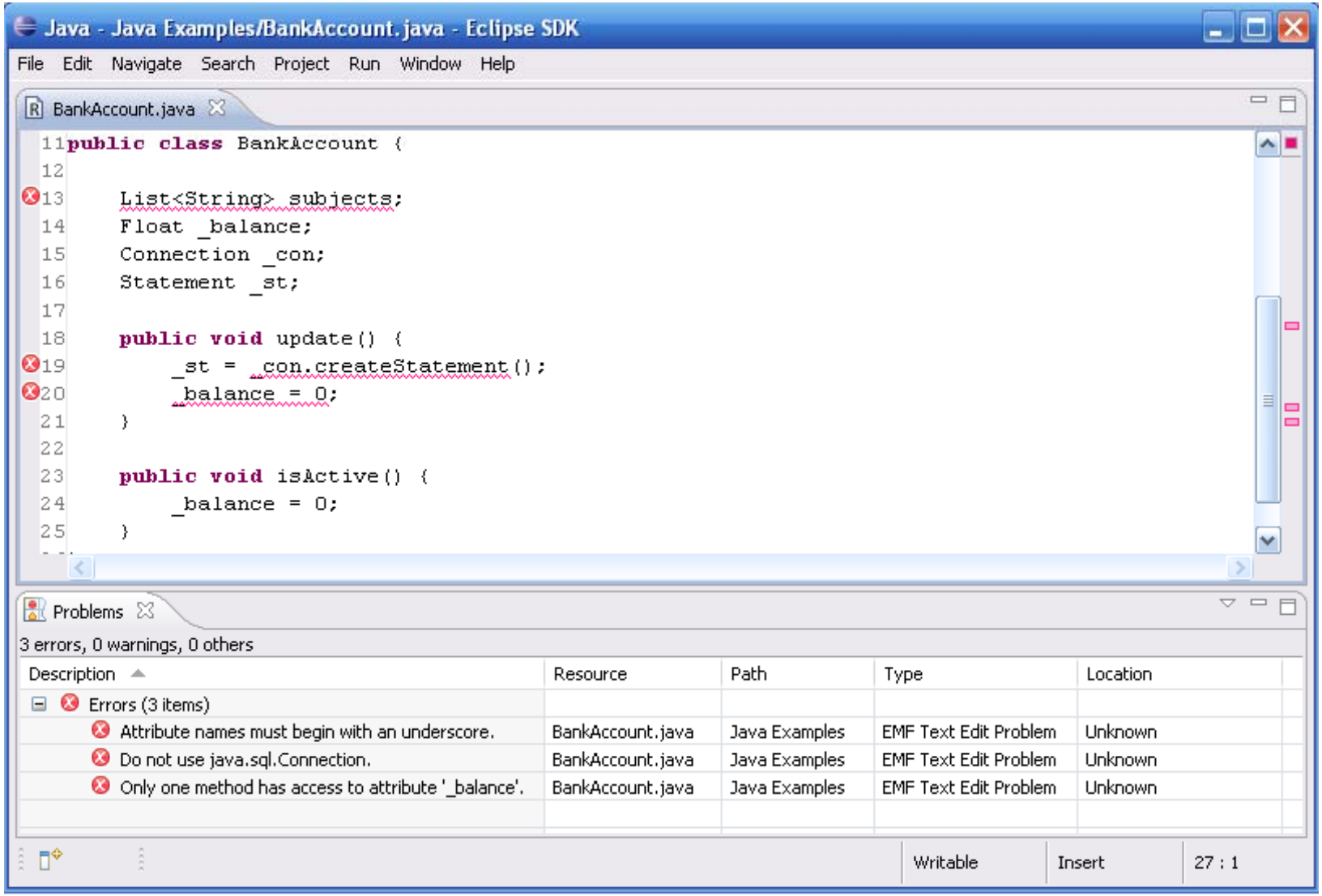
- Forbid calls to specific methods

```
java.sql.Connection _con;
java.sql.Statement _st = _con.createStatement();
```

- Attribute names must begin with an underscore

```
List<String> subjects;
```

# Example Java



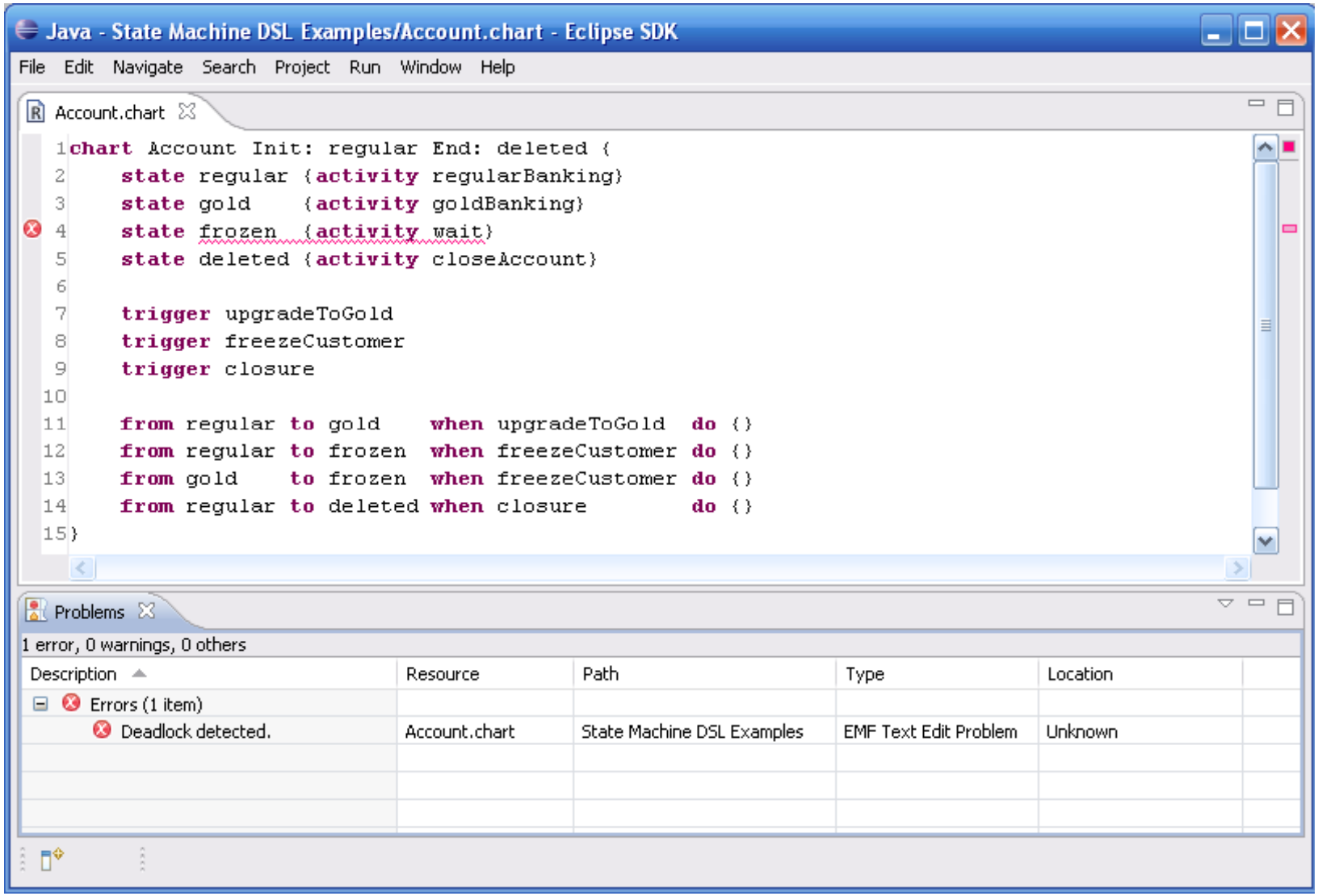
# Example DSL

- Language specific for a domain
- For example: A language for state charts can be defined
- There should be checks for deadlocks

```
chart Account Init: regular End: deleted {
    state regular {activity regularBanking}
    state gold    {activity goldBanking}
    state frozen  {activity wait}

    from regular to gold    when upgradeToGold  do {}
    from regular to frozen  when freezeCustomer do {}
    from gold    to frozen  when freezeCustomer do {}
```

# Example DSL


Java - State Machine DSL Examples/Account.chart - Eclipse SDK
File Edit Navigate Search Project Run Window Help
Account.chart
1 chart Account Init: regular End: deleted {
2 state regular {activity regularBanking}
3 state gold {activity goldBanking}
4 state frozen {activity wait}
5 state deleted {activity closeAccount}
6
7 trigger upgradeToGold
8 trigger freezeCustomer
9 trigger closure
10
11 from regular to gold when upgradeToGold do {}
12 from regular to frozen when freezeCustomer do {}
13 from gold to frozen when freezeCustomer do {}
14 from regular to deleted when closure do {}
15 }
Problems
1 error, 0 warnings, 0 others
Description
Resource
Path
Type
Location
Errors (1 item)
Deadlock detected.
Account.chart
State Machine DSL Examples
EMF Text Edit Problem
Unknown

# Conclusion

| Pros | Cons |
| --- | --- |
| language independence | meta model must be created for each language |
| solution not restricted to one editor | need for ecore-based AST |
| rules are based on standard language (OCL) | OCL queries may become very large |
| | restricted by the expressive power of OCL |

# Future work

- Evaluation using new languages, especially textual DSLs form interesting use cases
- Determination where OCL reaches its limits when used for source code analysis
- Getting a clear understanding about the possible types of analysis
- Compare our method with specialized tools for existing languages (can it compete?)
- Handling the complexity of OCL queries

# Questions?

Thanks for your attention!

# Example Java – java.sql.Connection

```
self.typeDeclarations->select(class |
   class.oclIsKindOf(Class)).oclAsType(Class).members->select(method |
   method.oclIsKindOf(Method)).oclAsType(Method).body->statements-
   >select(ass| ass.oclIsKindOf(Assignment)).oclAsType(Assignment)
   .value->select(vr| vr.oclIsKindOf(VariableReference))
   .oclAsType(VariableReference)->select(v|v.variable.type
   .oclAsType(Class).name = 'Connection')
```

# Example Java – enforce underscore

```
self.typeDeclarations->select(class |
   class.oclIsKindOf(Class)).oclAsType(Class).members->select(v |
   v.oclIsKindOf(Variable)).oclAsType(Variable)->select(var|
   var.name.substring(1,1)<>'_')
```