TECHNISCHE UNIVERSITÄT DRESDEN

Technical University Dresden Department of Computer Science Chair for Software Technology

31. Generic Refactoring for Programming and Modeling Languages

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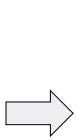
1.From Code to Models
2.Related Work
3.Role-based Generic Model Refactoring
4.Evaluation
5.Contributions

Obligatory Literature

- Sander Tichelaar, Stéphane Ducasse, Serge Demeyer, and Oscar Nierstrasz. A meta-model for language-independent refactoring. In Proceedings of International Symposium on Principles of Software Evolution (ISPSE '00), pages 157-167. IEEE Computer Society Press, 2000.
  - doi:10.1109/ISPSE.2000.913233,
- MOOSE framework http://www.moosetechnology.org/
- Jan Reimann, Mirko Seifert, and Uwe Aßmann. Role-based generic model refactoring. In Dorina C. Petriu, Nicolas Rouquette, and Øystein Haugen, editors, MoDELS (2), volume 6395 of Lecture Notes in Computer Science, pages 78-92. Springer, 2010. Best Paper Award.

An Example of Code Refactoring
Extract Method (Outlining)

```
1  public class HelloJava {
2
3      private static int i = 0;
4
5      public static void main(String[] args) {
6          System.out.println("Hello Java");
7          for (; i <= 10; i++) {
8              System.out.println("value: " + i);
9          }
10     }
11
12 }
```



```
1  public class HelloJava {
2
3      private static int i = 0;
4
5      public static void main(String[] args) {
6          System.out.println("Hello Java");
7          iterate();
8      }
9
10     private static void iterate() {
11         for (; i <= 10; i++) {
12             System.out.println("value: " + i);
13         }
14     }
15 }
```

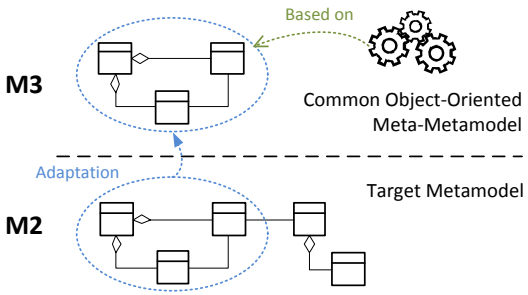

From Code to Models
Why is Refactoring needed for Models?

- Model-Driven Software Development:
  - Models are partial code
  - Models are primary artefacts in MDSD
  - Good model design is essential for understandability
  - Some models are domain-specific, and belong to **domain-specific languages (DSL)**

Why should it be generic?

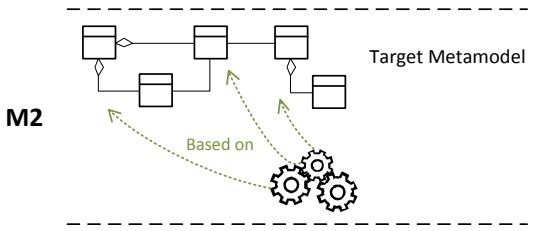
- Known code refactorings are transferable to many DSLs
- Core steps of refactorings are equal for different metamodels
- A lot of additional effort to specify refactorings from scratch

- Common meta-metamodel to static
- Lack of exact control of structures to be refactored



[Moha, Naouel, Vincent Mahé, Olivier Barais und Jean-Marc Jézéquel: *Generic Model Refactorings*, MODELS 2009]

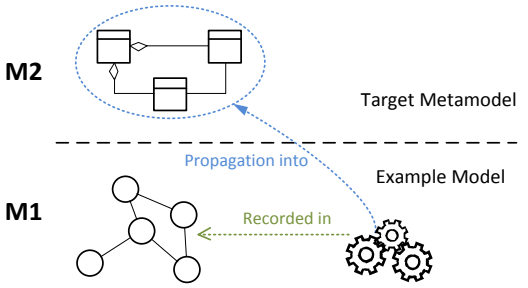
- No genericity
- No reuse



[Taentzer, Gabriele, Dirk Müller and Tom Mens: Specifying Domain-Specific Refactorings for AndroMDA Based on Graph Transformation, AGTIVE 2007]

M1 layer specification

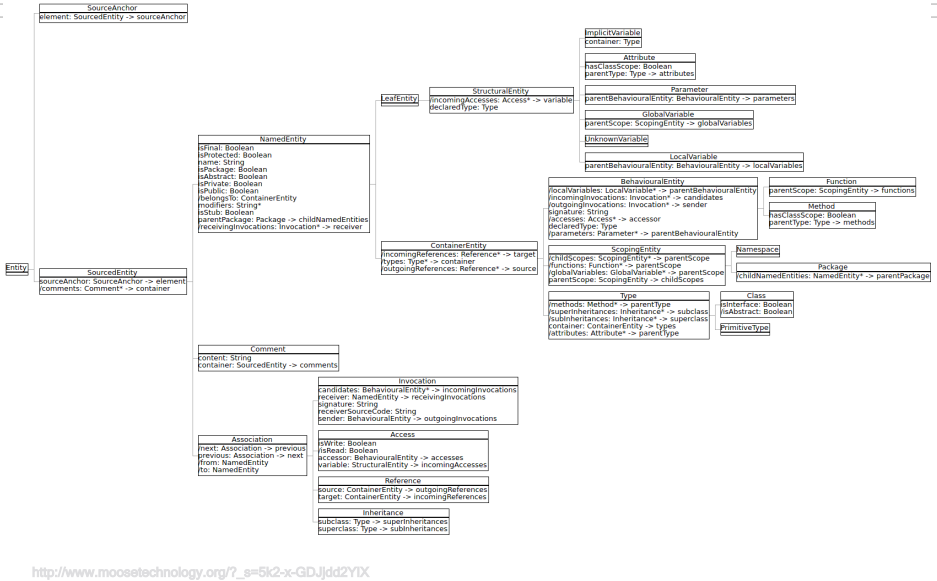
- No genericity
- No reuse



[Brosch, Petra, Philip Langer, Martina Seidl, Konrad Wieland, Manuel Wimmer, Gerti Kappel, Werner Retschitzegger and Wieland Schwinger: *An Example is Worth a Thousand Words: Composite Operation Modeling By-Example*, MODELS 2009]

31.2 MOOSE

FAMIX Upper Metamodel



http://www.moosetechnology.org/?_s=5k2-x-GDJjdd2YIX

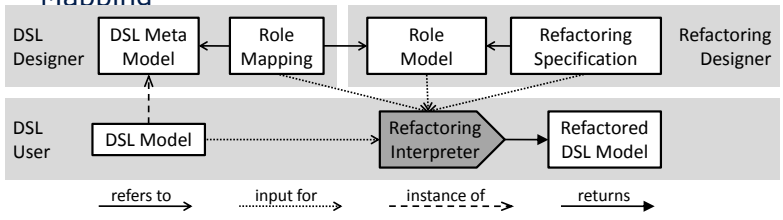
- The FAMIX upper metamodel
  - Enables generic refactoring for all entities *above methods, not touching method bodies,* such as class restructurings, class renamings, package refactorings, etc.
- The MOOSE framework supplies basic graph algorithms for reengineering and refactoring:
  - Strongly connected components
  - Dominance
  - Kruskal spanning trees
- Concept recognition in texts
- Formal concept analysis

31.2 Refactory

The generic refactorer of TU Dresden
Jan Reimann

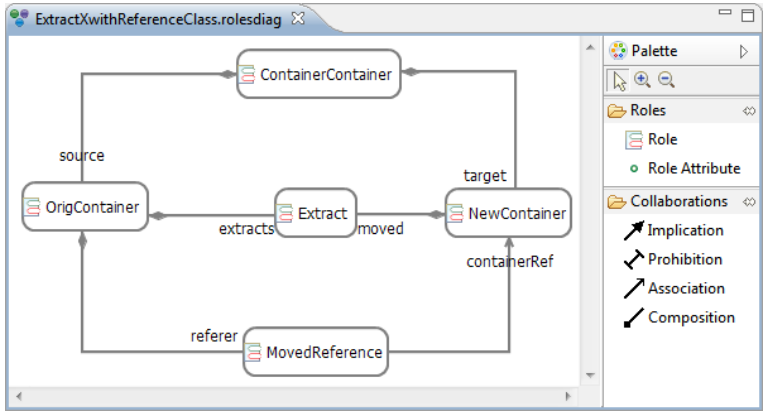
Role-based Design (Reenskaug, Riehle & Gross)

- Definition of collaborations of objects in different contexts
- Here: Context = model refactoring
- Participants play role in concrete refactoring → Role Model
- Role-based transformation → Refactoring Specification
- Application to desired parts of metamodel → Role Mapping



Role-based Metamodeling

- Refactory sees a role model (a view) of the metamodel



Refactoring Specification on Role Model

- The roles of this role-metamodel can be used to write refactoring scripts and operators

ExtractXwithReferenceClass.refspec

```
1  REFACTORING FOR <ExtractXwithReferenceClass>
2
3  STEPS {
4      object containerContainerObject := ContainerContainer from uptree(INPUT);
5      object origContainerObject := OrigContainer as trace(INPUT);
6      index extractsIndex := first(INPUT);
7
8      create new nc:NewContainer in containerContainerObject;
9      assign nc.newName;
10     move OrigContainer.extracts to nc;
11     create new mr:MovedReference in origContainerObject at extractsIndex;
12     set use of nc in mr;
13 }
```


Role Mapping to Specific DDL

- A **mapping** maps roles to metaclasses in a concrete metamodel

extractProcedure.rolemapping

```
1  ROLEMODELMAPPING FOR <http://www.emftext.org/language/pl0>
2
3  "Extract Procedure" maps <ExtractXwithReferenceClass> {
4      OrigContainer := Body {
5          extracts := statements;
6      };
7      Extract := Statement;
8      NewContainer := ProcedureDeclaration (newName -> name)  {
9          moved := block -> body -> statements;
10     } ;
11     MovedReference := CallStatement {
12         containerRef := procedure;
13     };
14     ContainerContainer := Block {
15         source := body;
16         target := procedures;
17     } ;
18 }
```

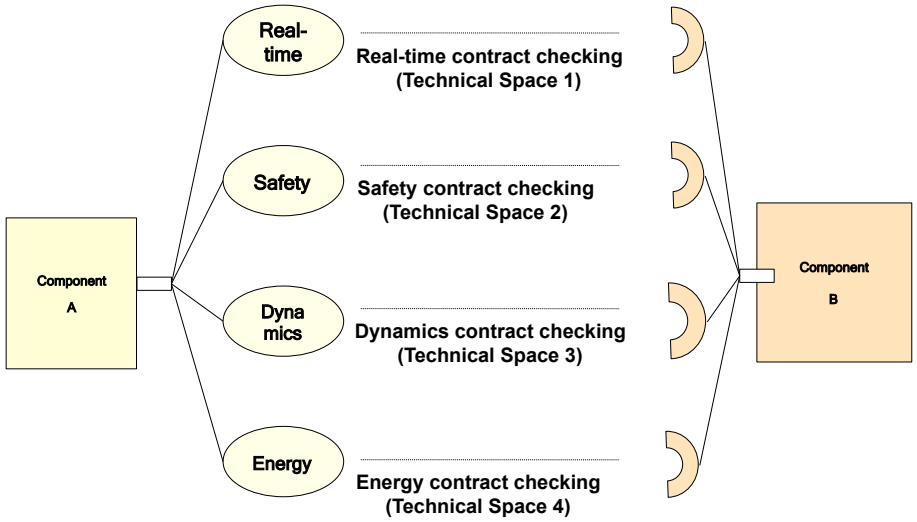

Starting point

- 16 target metamodels of different complexity (Java, UML, Ecore…)
- 53 concrete model refactorings

Result

- 9 generic model refactorings
- 6 metamodel specific extensions were needed
- 7 metamodels are multiple target of same model refactoring
- 2 metamodels are at least target of every model refactoring

New: Multi-Quality Contracts in CPS (Multi-Technical Spaces)



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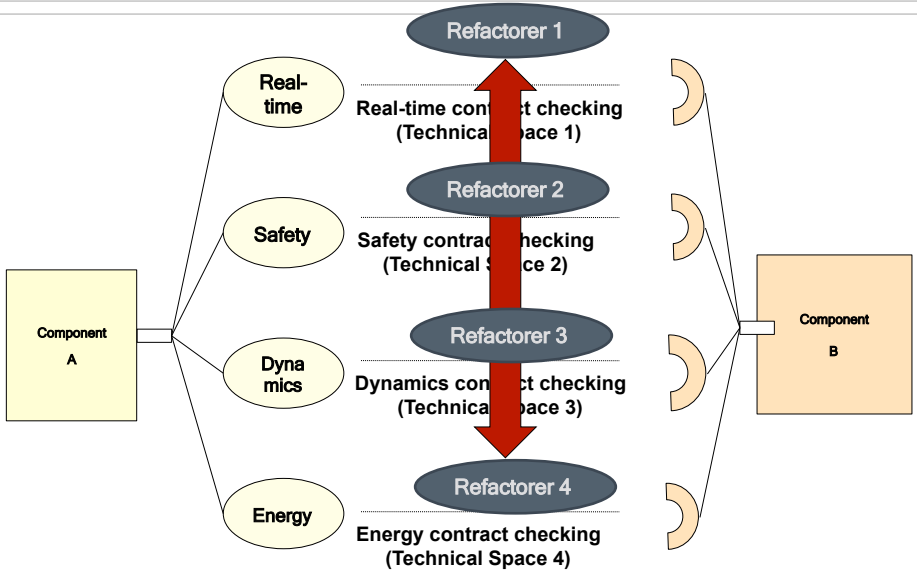

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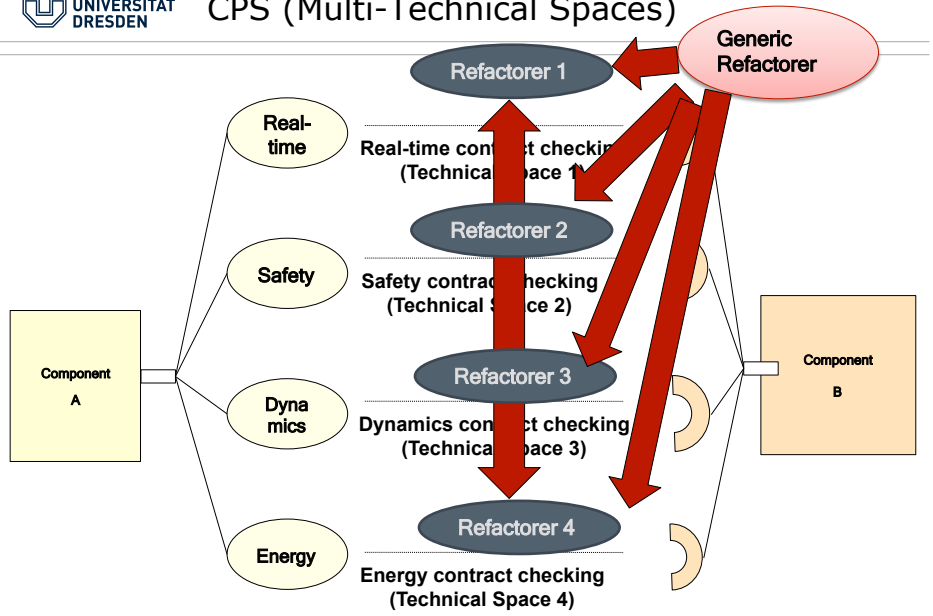

Lessons Learned

- Refactorings generically specifiable if abstractable and structurally transferable
- Metamodel-specific refactorings possible
- Design decisions
  - ”Specific” generic refactoring
  - Metamodel-specific extension or
  - Implementation of metamodel-specific refactoring (Java)
- Reuse beneficial if model refactoring appliable to at least two metamodels

- Generic refactoring works!!
- Definition of generic model refactorings based on roles
  - Role models form a dedicated context for every model refactoring
- Approach allows both for genericity and control of the structures to be refactored
- Control is achieved by mapping of role models into arbitrary sections of the target metamodel
- Interpretation by resolving roles and collaborations into the target metamodel

Outlook

- Pre- and postconditions with role-based OCL interpreter
- Preservation of behavior with formalization of semantics
- Specification of model smells
- Co-Refactoring
- Automatic mapping to metamodels

Students looked for in Resubic Lab
Co-Refactoring of mulit-quality specificatios
http://resubic.inf.tu-dresden.de

http://www.emftext.org/refactoring

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Mapping to Paths