



Grupo de Investigación en  
Reutilización y Orientación a  
Objeto

# Towards a Language Independent Refactoring Framework

Authors:

Carlos López

Raúl Marticorena

Yania Crespo

Francisco Javier Pérez

[clopezno@ubu.es](mailto:clopezno@ubu.es)

[rmartico@ubu.es](mailto:rmartico@ubu.es)

[yania@infor.uva.es](mailto:yania@infor.uva.es)

[jperez@infor.uva.es](mailto:jperez@infor.uva.es)

# Outline



- Introduction
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- Example: UML 2.0 as Metamodel
  - Statement
  - UML Mapping
- Conclusions



# Introduction

- **Introduction**
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- Example: UML 2.0 as Metamodel
  - Statement
  - UML Mapping
- Conclusions

3 of 24

- **Refactoring** [Fowler, 2000]
  - “Process of changing a software system in such a way that it does not alter external behavior of the code yet improve its internal structure”
- **Open Research Trends** [Mens et al., 2004]
  - Define new refactorings
  - Identify code defects (*Bad Code Smells*)
  - Apply refactorings
  - **Tool support with language independence**
  - etc...



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  - Framework Core
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  - Statement
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4 of 24

## ■ Techniques

- Abstract Syntax Tree (AST)
- **Metamodel**
  - Language Independence

## ■ Goals



**Display our proposal using a metamodel**



**Study the suitability of the UML 2.0 metamodel** [OMG, 2004]

- new "action" concept as support to refactoring tools



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- **Related Works**
- Refactoring Framework
  - Framework Core
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  - Statement
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5 of 24

- **FAMIX Metamodel** [Tichelaar et al., 2000]
  - Store information
    - *Class, Method, Attribute, Inheritance, etc.*
    - *Invocation*
      - represents the definition of a *Method* calling another *Method*
    - *Access*
      - represents a method body accessing an *Attribute*.
  - Aimed at the integration of several CASE tools
    - MOOSE as Refactoring tool [Ducasse et al., 2000]
  - Not contains features related to
    - Advance inheritance
    - Genericity



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- Introduction
- **Related Works**
- Refactoring Framework
  - Framework Core
  - Framework Extension
- Example: UML 2.0 as Metamodel
  - Statement
  - UML Mapping
- Conclusions

6 of 24

- **GrammyUML** [Van Gorp et al., 2003]
  - Focus on UML 1.4.
    - From a point of view of
      - tool compatibility
      - understandability
  - Argue that UML 1.4 metamodel is inadequate
    - For maintaining the consistency between a refactored design model and the corresponding program code
  - Propose a UML 1.4 Metamodel Extension
    - Add *LocalVariable* as a specialization of *ModelElement*
    - Add *SingleTargetAction* as a specialization of *Action*
    - 6 more...
  - Not considering the following UML packages
    - Action Semantic Package
    - Genericity Package



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- Introduction
- **Related Works**
- Refactoring Framework
  - Framework Core
  - Framework Extension
- Example: UML 2.0 as Metamodel
  - Statement
  - UML Mapping
- Conclusions

7 of 24

## ■ MOON [Crespo 2000]

### ■ Minimal Object-Oriented Notation

- minimal abstractions for refactoring

### ■ Storing:

- Classes, relationships, correctness rules to inheritance, genericity, variants on the type system, etc
- Entity
  - Any concept in source code that has a type
  - *self reference, super reference, local variable, method formal argument, class attribute and function result*
- Instruction
  - *creation, assignment, call and compound instructions*

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- Introduction
- Related Works
- **Refactoring Framework**
  - **Framework Core**
  - Framework Extension
- Example: UML 2.0 as Metamodel
  - Statement
  - UML Mapping
- Conclusions

8 of 24

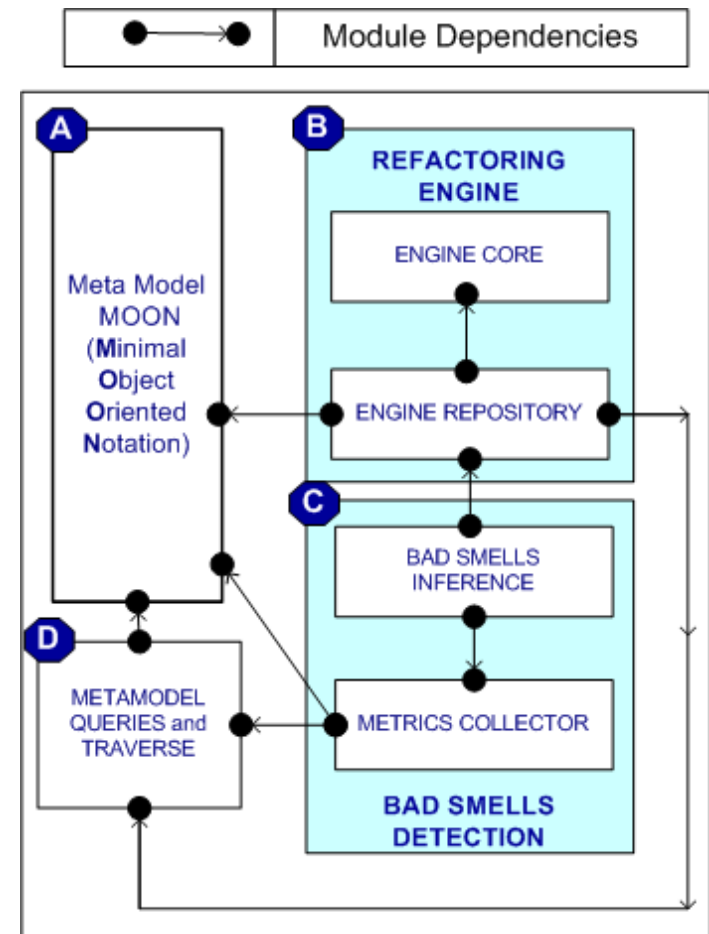
## ■ Proposed framework in previous works

- To define, to detect and to execute refactorings

## ■ Framework Core

### ■ Functionality

- A** Code information
- B** Transformation Actions
- B** Compose Refactorings
- C** Metric Collector
- C** Code Defect Detection
- D** Query System



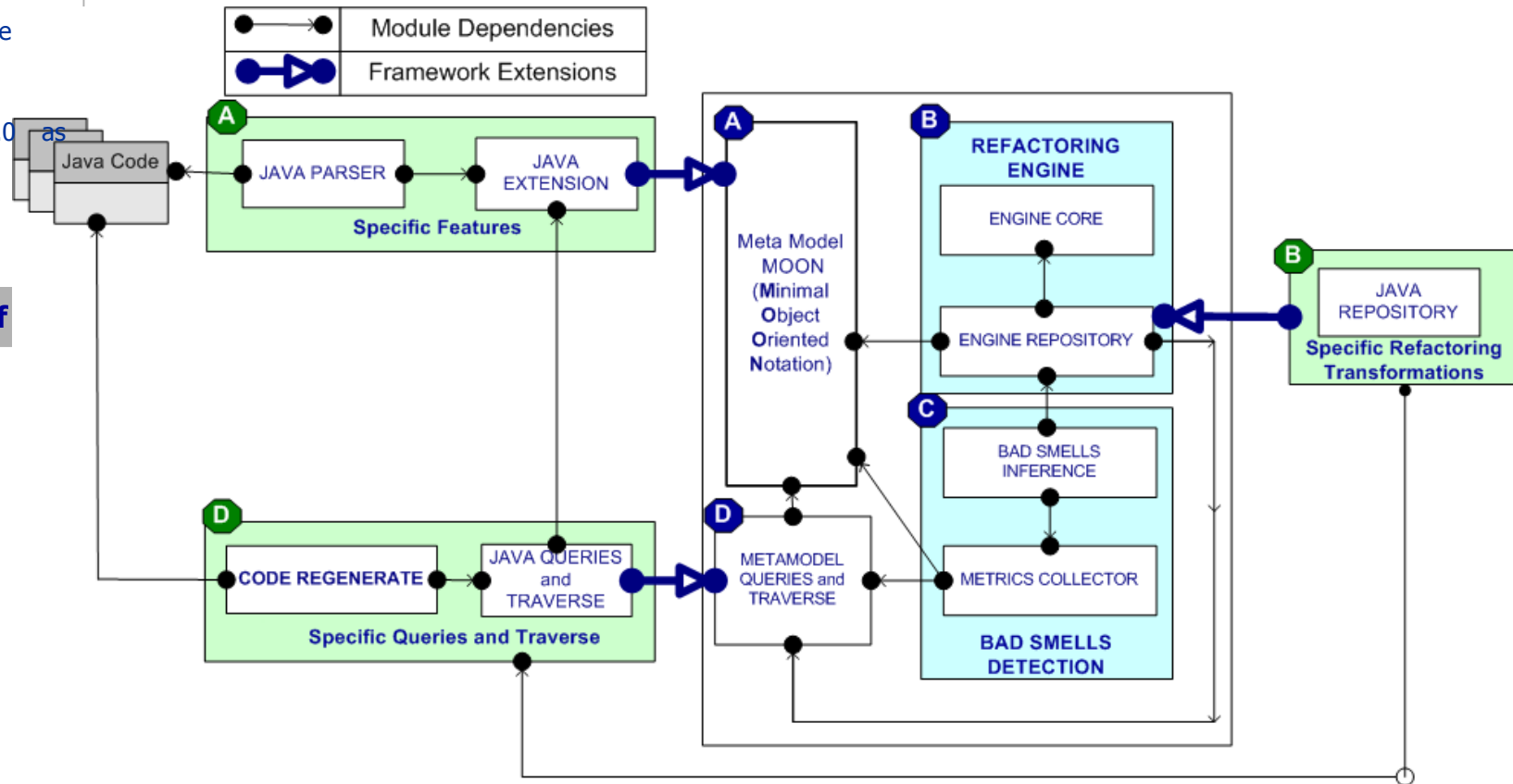


# Refactoring Framework

## ■ Framework Java Extension

- Introduction
- Related Works
- **Refactoring Framework**
  - Framework Core
  - **Framework Extension**
- Example: UML 2.0 as Metamodel
  - Statement
  - UML Mapping
- Conclusions

9 of



# Example: UML 2.0 as Metamodel

- Introduction
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- **Example: UML 2.0 as Metamodel**
  - Statement
  - UML Mapping
- Conclusions

10 of 24

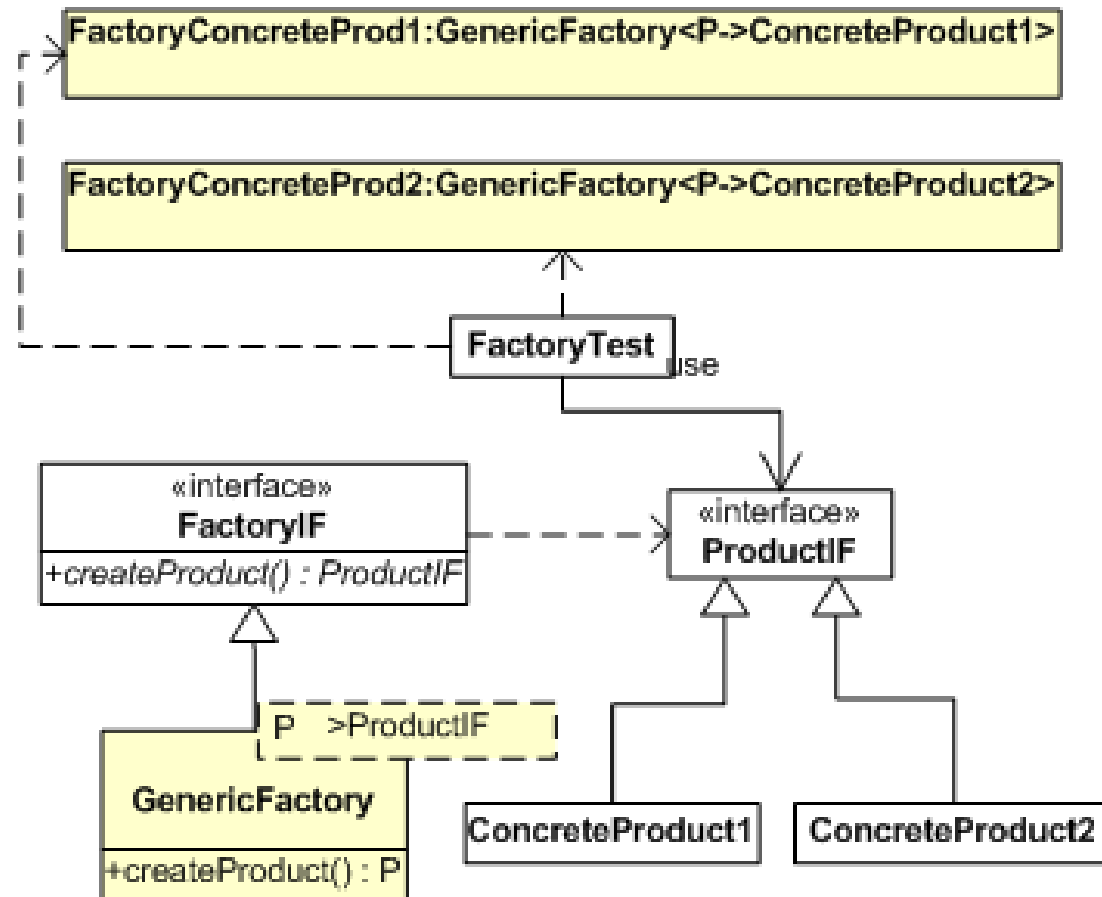
- Evaluate UML 2.0 as candidate metamodel in the framework (Module A)
  - Understandability
  - Exchange model
- Include new abstractions
  - Actions
  - Genericity
- Example
  - Factory Method Design Pattern
  - Generic implementation variant
    - Programming Language Java 1.5

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- Introduction
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- **Example: UML 2.0 as Metamodel**
  - **Statement**
  - UML Mapping
- Conclusions

11 of 24

## ■ Example: Class Diagram



# Example: UML 2.0 as Metamodel

- Introduction
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- **Example: UML 2.0 as Metamodel**
  - **Statement**
  - UML Mapping
- Conclusions

12 of 24

## ■ Example: Generic class partial code

```

public class GenericFactory <P extends ProductIF>
    implements FactoryIF{

    private Class<P> c;

    public GenericFactory (Class<P> c) {
        this.c = c;
    }

    public P createProduct() {
        P product = null;

        try{product=c.newInstance();}
        catch(InstantiationException e){ }
        catch(IllegalAccessException e){ }

        return product;
    }
}

```

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- Introduction
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- **Example: UML 2.0 as Metamodel**
  - **Statement**
  - UML Mapping
- Conclusions

13 of 24

- **Example: Partial Code**
  - Generic instantiations of `GenericFactory`
  - Piece of code associated to `FactoryTest`

```
// Generic instantiation of Concrete Product1 Factory
FactoryIF factory1 =
    new GenericFactory<ConcreteProduct1>(ConcreteProduct1.class);
// Generic instantiation of Concrete Product2 Factory
GenericFactory factory2 =
    new GenericFactory<ConcreteProduct2>(ConcreteProduct2.class);
```

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- Introduction
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- **Example: UML 2.0 as Metamodel**
  - Statement
  - **UML Mapping**
- Conclusions

14 of 24

## ■ UML Mapping: `GenericFactory.createProduct`

### ■ Mapping questions

- 1 Exception Handlers
  - `ProtectedNode` and `ExceptionHandler` classes
    - In Behavior concretely in Action section [OMG 2004]
- 2 Instruction Sequences
  - Activity Diagrams [Booch et al.,1999]
    - In Behavior concretely in Action section [OMG 2004]
- 3 Call Instructions
  - Actions can be contained in activities that provide a context
- 4 Parametric Types

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- Introduction
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- **Example: UML 2.0 as Metamodel**
  - Statement
  - **UML Mapping**
- Conclusions

15 of 24

## 1 Exception handlers

- ProtectedNode
  - Group an activity set that could throw one or more exceptions
- ExceptionHandler
  - Specify the action sequence to be executed in case that exceptions happen

## 2 Instruction Sequences

- Activity Diagrams can model an operation [Booch et al., 1999]
- An action flow is represented

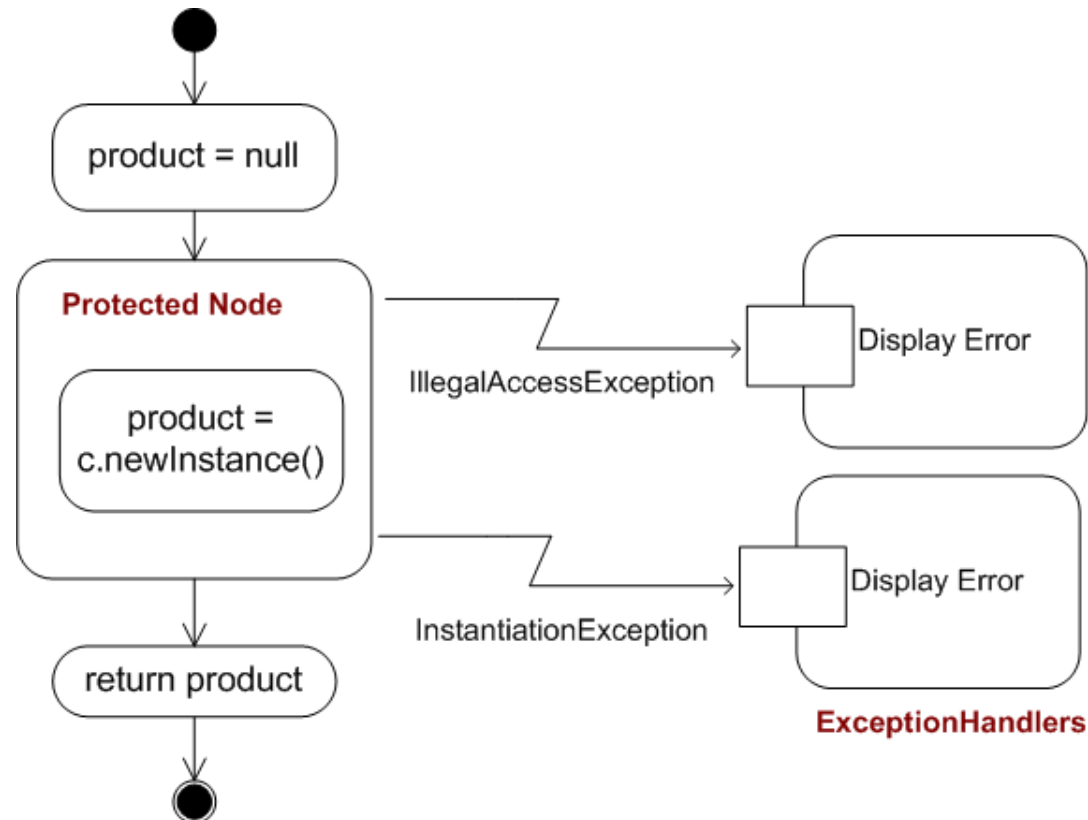
# Example: UML 2.0 as Metamodel

## ■ Mapping

1

2

`GenericFactory.createProduct`



- Introduction
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- **Example: UML 2.0 as Metamodel**
  - Statement
  - **UML Mapping**
- Conclusions

16 of 24



# Example: UML 2.0 as Metamodel

- Introduction
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- **Example: UML 2.0 as Metamodel**
  - Statement
  - **UML Mapping**
- Conclusions

17 of 24

## 3 Call Instructions

### ■ *Actions*

- A fundamental unit of behavior specification
- Each activity is defined by a set of actions that provide precise semantics
- Take input set (`InputPin`) and transform it to an output set (`OutputPin`)
- **54 classes** in UML 2.0 Action Subsystem

# Example: UML 2.0 as Metamodel

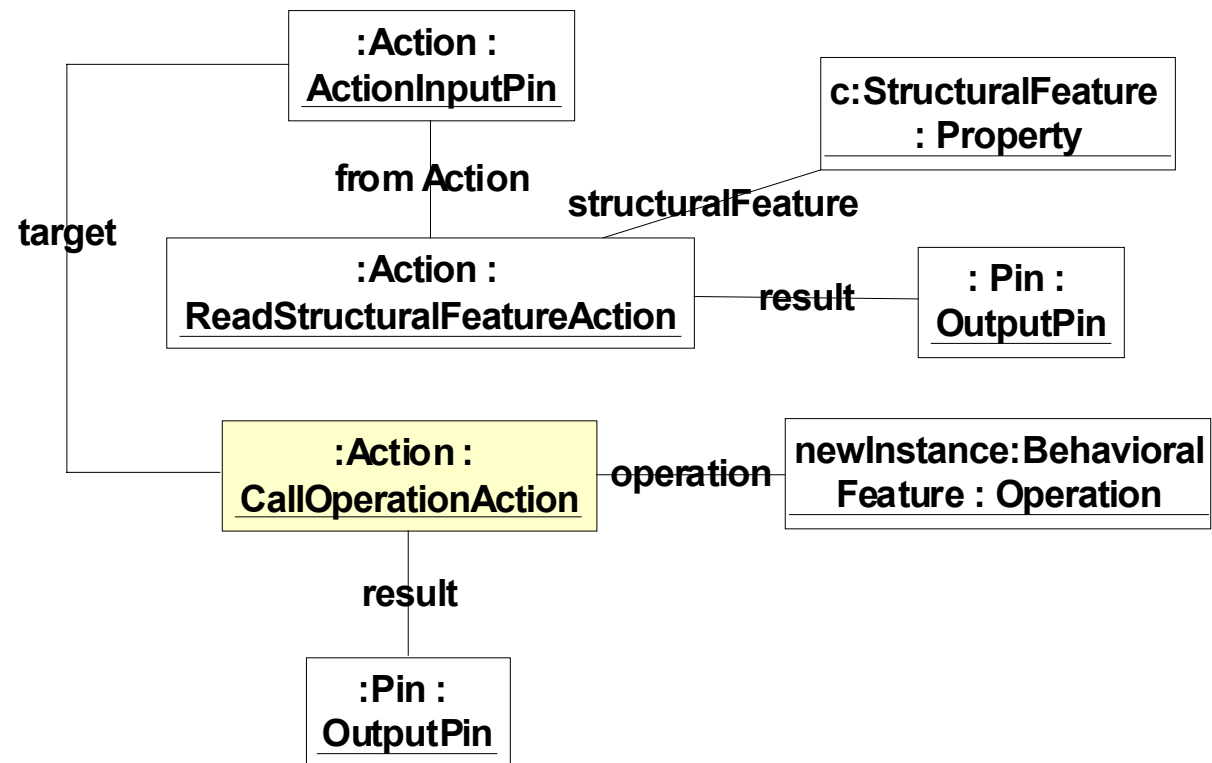
- Introduction
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- **Example: UML 2.0 as Metamodel**
  - Statement
  - **UML Mapping**
- Conclusions

18 of 24

## ■ Mapping 3

■ *Call Instruction:* `c.newInstance()`

product =  
`c.newInstance()`



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- Introduction
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- **Example: UML 2.0 as Metamodel**
  - Statement
  - **UML Mapping**
- Conclusions

19 of 24

## 4 Parametric Types

- *Support to parameterize classifiers (Classifiers), packages (Packages) and operations (Operations)*
- *Support to generic instantiations*
- Some subsystem classes
  - *TemplateableElement*
  - *TemplateSignature*
  - *TemplateParameter*
  - *ParameterableElement*
  - *TemplateParameterSubstitution*
  - *TemplateBinding*

# Example: UML 2.0 as Metamodel

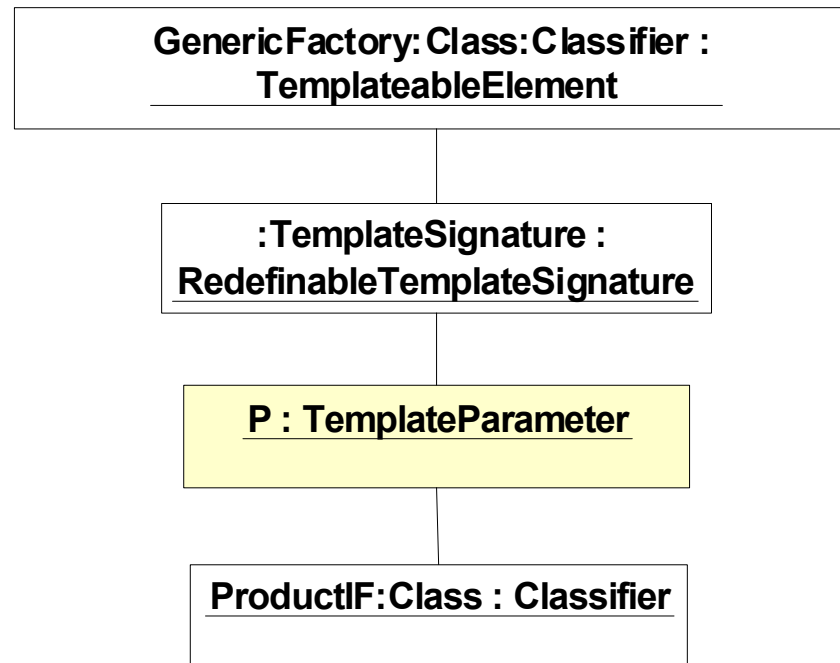
- Introduction
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- **Example: UML 2.0 as Metamodel**
  - Statement
  - **UML Mapping**
- Conclusions

20 of 24

## ■ Mapping 4

### ■ *Generic class signature*

*class GenericFactory <P extends ProductIF>*



# Example: UML 2.0 as Metamodel

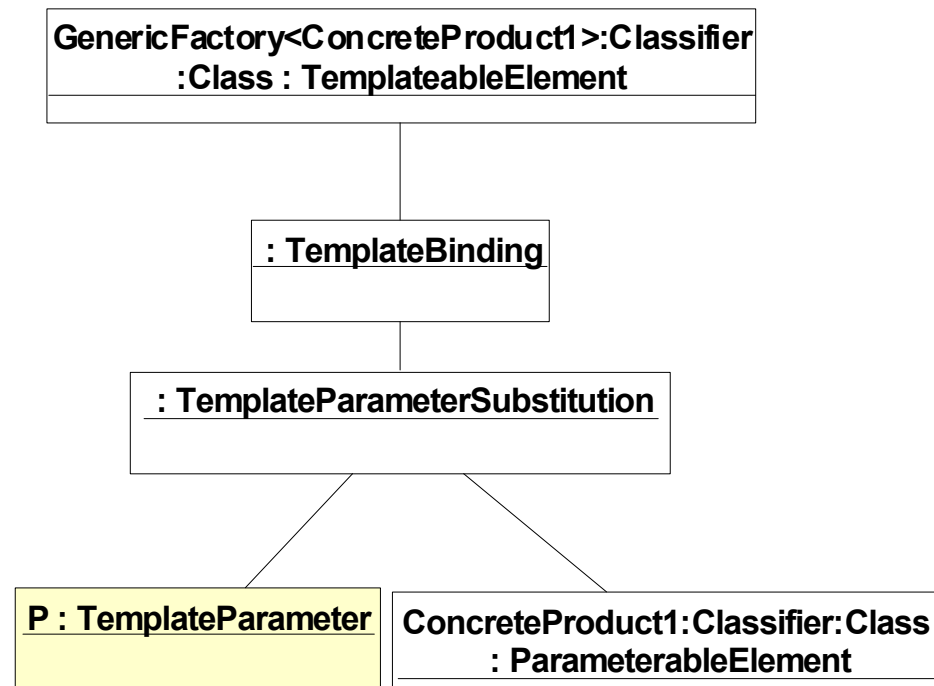
- Introduction
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- **Example: UML 2.0 as Metamodel**
  - Statement
  - **UML Mapping**
- Conclusions

21 of 24

## ■ Mapping 4

### ■ *Generic instantiation*

*GenericFactory<ConcreteProduct1>*





# Conclusions

- Introduction
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- Example: UML 2.0 as Metamodel
  - Statement
  - UML Mapping
- **Conclusions**

22 of 24

- UML can be used to store source code
- High complexity in the metamodel structure
  - Structure is three times higher than in the MOON metamodel

MOON		UML	
Subsystem	Number of classes	Sections	Number of classes
module	24	classes	55
inheritance	7		
genericity	5	templates	20
instructions	20	actions	54
		activities	52
<b>Total</b>	<b>56</b>	<b>Total</b>	<b>181</b>



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- Introduction
- Related Works
- Refactoring Framework
  - Framework Core
  - Framework Extension
- Example: UML 2.0 as Metamodel
  - Statement
  - UML Mapping
- **Conclusions**

23 of 24

- Experiment is limited
  - Not include all Object-Oriented code abstractions
- UML structure cannot represent:
  - Typecast
  - Multiple bounds parametric type
  - Etc.
- MOON cannot represent:
  - Conditionals
  - Loops
  - Etc.
- Proposed solution:
  - Based on minimal core (MOON metamodel)
  - UML metamodel extension as future direction
    - extending the current MOON metamodel in the same way as we have done with programming languages

Thank you very much

