Model-Based Software Engineering

Lecture 04 – OCL and Concrete Syntax

Prof. Dr. Joel Greenyer

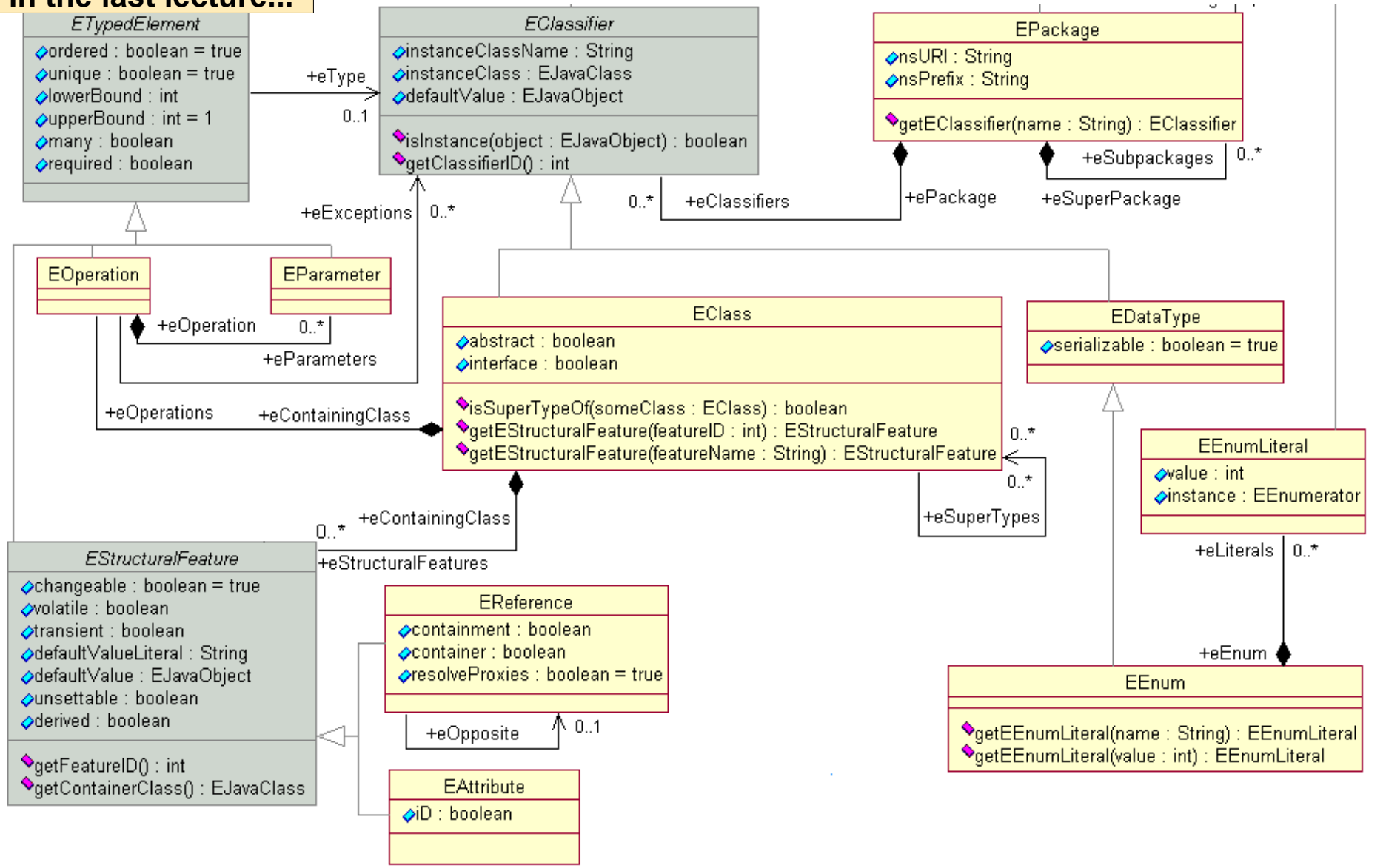
April 26, 2016

Acknowledgment

- The slides of this lecture are inspired by lecture slides from
  - *Ekkart Kindler*: Course on Advanced Topics in Software Engineering, DTU Compute, 2015.
    - http://www2.imm.dtu.dk/courses/02265/f15/schedule.shtml
  - *Ina Schäfer, Christoph Seidl*: Modellbasierte Software-entwicklung, TU Braunschweig, 2015.
  - *Steffen Becker*: Model-Driven Software Development, Universität Paderborn, 2013
  - The Eclipse Open Model CourseWare (OMCW) Project:
    - https://eclipse.org/gmt/omcw/

A Close Look at the Ecore Meta-Metamodel

in the last lecture...

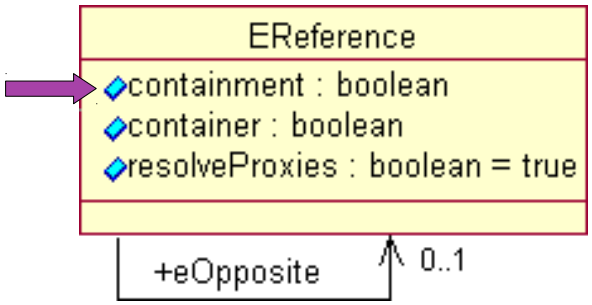


see http://download.eclipse.org/modeling/emf/emf/javadoc/2.9.0/org/eclipse/emf/ecore/package-summary.html

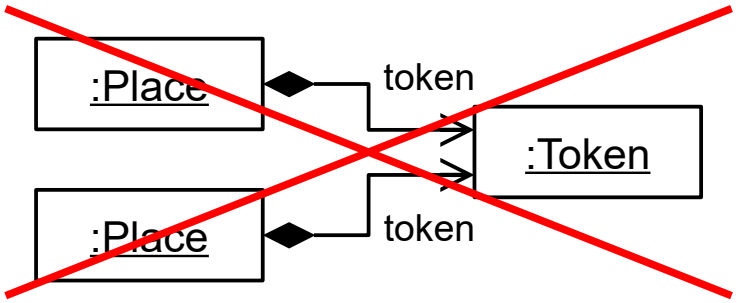
Specialties of EReferences

in the last lecture...

- **Containment**:
  - An object can only be be contained in *at most one* other object at a time
    - it can be target of at most one containment link at a time



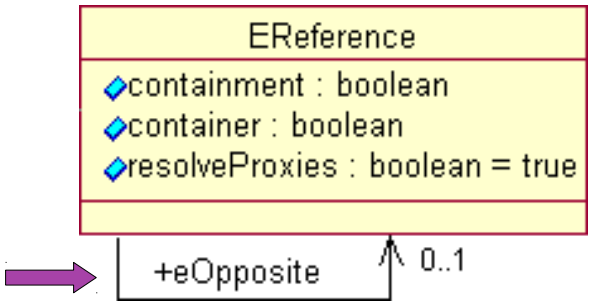
- Example:



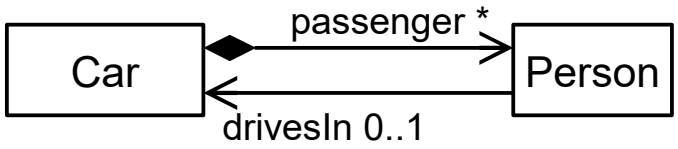
Specialties of EReferences

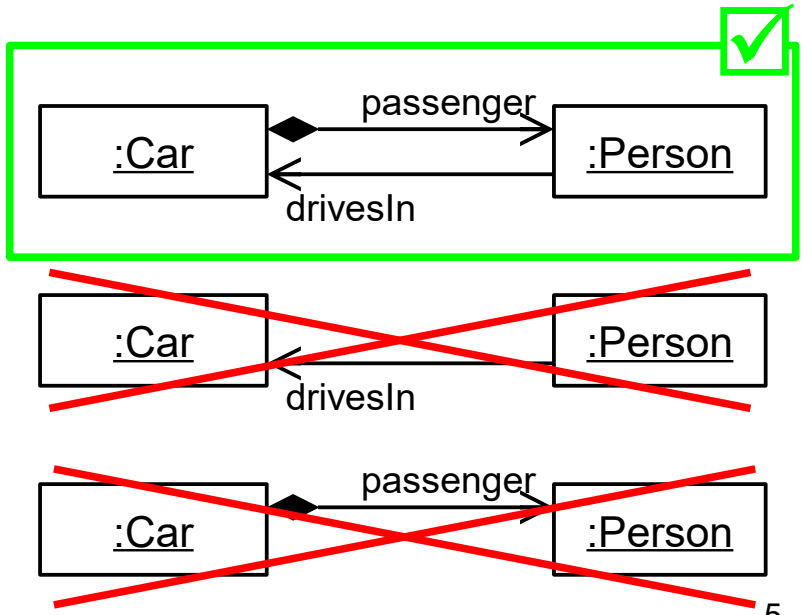
in the last lecture...

- **eOpposite**:
  - Two EReferences in opposite directions between two EClasses can be “opposites”
  - Thereby forming a bidirectional relationship
  - At the object level, there must be bidirectional links



- Example:



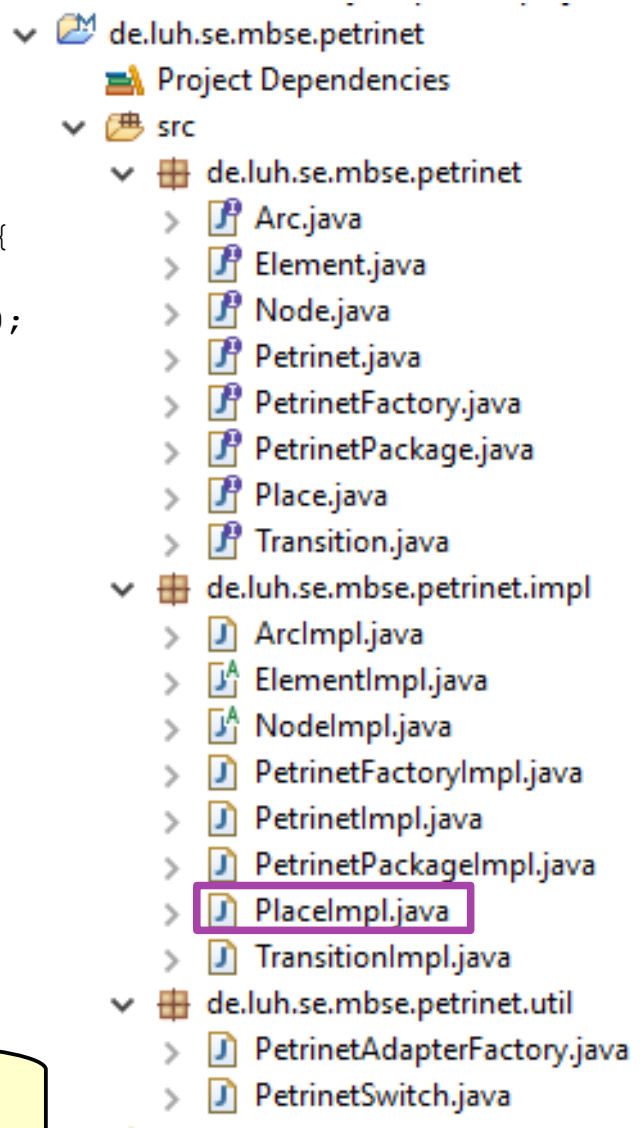


EMF Code Generation

in the last lecture...

- Separation of Interfaces and Implementation

```
public class PlaceImpl extends NodeImpl implements Place {

    protected static final int INTIAL_MARKING_EDEFAULT = 0;
    protected int intialMarking = INTIAL_MARKING_EDEFAULT;

    public int getIntialMarking() {
          return intialMarking;
    }

    public void setIntialMarking(int newIntialMarking) {
          int oldIntialMarking = intialMarking;
          intialMarking = newIntialMarking;
          if (eNotificationRequired())
                eNotify(new ENotificationImpl(this,
                Notification.SET,
                PetrinetPackage.PLACE__INTIAL_MARKING,
                oldIntialMarking,
                intialMarking));
    }

    ...

} //PlaceImpl
```



Notification mechanism (observer pattern) built in

Dynamic EMF

- The generated code allows us to create instances of our Ecore models
  - for example (factory method):

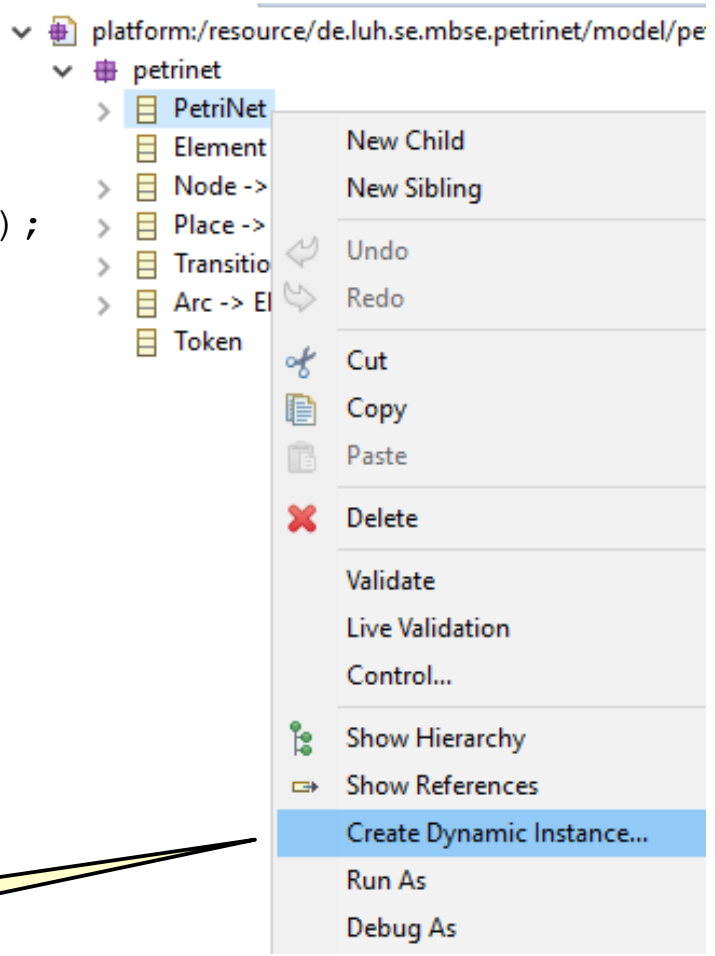
```
public Petrinet createPetrinet() {
    PetrinetImpl petrinet = new PetrinetImpl();
    return petrinet;
}
```

Dynamic EMF

- The generated code allows us to create instances of our Ecore models
  - for example (factory method):

```
public Petrinet createPetrinet() {
    PetrinetImpl petrinet = new PetrinetImpl();
    return petrinet;
}
```

- But EMF also supports working with **dynamic instances**
- EMF **interprets** the metamodels to allow us to work on instance models without code generation:



creating a dynamic object via the UI

SOFTWARE ENGINEERING

Dynamic EMF

- creating models and instances dynamically via the API:

Dynamic EMF

- creating models and instances dynamically via the API:

```
// create package
EPackage petrinetPackage = EcoreFactory.eINSTANCE.createEPackage();
```

Dynamic EMF

- creating models and instances dynamically via the API:

```
// create package
EPackage petrinetPackage = EcoreFactory.eINSTANCE.createEPackage();

//create Place class
EClass placeClass = EcoreFactory.eINSTANCE.createEClass();
placeClass.setName("Place");
petrinetPackage.getEClassifiers().add(placeClass);
```

Dynamic EMF

- creating models and instances dynamically via the API:

```
// create package
EPackage petrinetPackage = EcoreFactory.eINSTANCE.createEPackage();

//create Place class
EClass placeClass = EcoreFactory.eINSTANCE.createEClass();
placeClass.setName("Place");
petrinetPackage.getEClassifiers().add(placeClass);

//create initialMarkings attribute and add it to the Place class
EAttribute initialMarkingsAttribute
                = EcoreFactory.eINSTANCE.createEAttribute();
initialMarkingsAttribute.setName("initialMarkings");
initialMarkingsAttribute.setEType(EcorePackage.eINSTANCE.getEInt());
placeClass.getEAttributes().add(initialMarkingsAttribute);
```

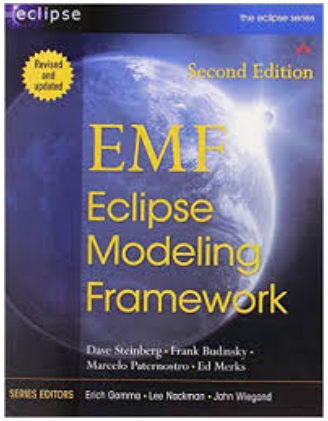
Dynamic EMF

- creating models and instances dynamically via the API:

```
// create package
EPackage petrinetPackage = EcoreFactory.eINSTANCE.createEPackage();

//create Place class
EClass placeClass = EcoreFactory.eINSTANCE.createEClass();
placeClass.setName("Place");
petrinetPackage.getEClassifiers().add(placeClass);

//create initialMarkings attribute and add it to the Place class
EAttribute initialMarkingsAttribute
                = EcoreFactory.eINSTANCE.createEAttribute();
initialMarkingsAttribute.setName("initialMarkings");
initialMarkingsAttribute.setEType(EcorePackage.eINSTANCE.getEInt());
placeClass.getEAttributes().add(initialMarkingsAttribute);

//create dynamic instance of Place class
EFactory petrinetFactory = petrinetPackage.getEFactoryInstance();
EObject place =  petrinetFactory.create(placeClass);
place.eSet(initialMarkingsAttribute, 2);
```

EMF Resources

- D. Steinberg, F. Budinski, M. Paternostro, E.Merks: EMF: Eclipse Modeling Framework, Addison Wesley, 2nd edition, 2008.



- Online resources
  - http://www.vogella.com/tutorials/EclipseEMF/article.html
  - http://eclipsesource.com/blogs/tutorials/emf-tutorial/
  - There are many more online resources...

Model-Based Software Engineering

Lecture 04 – OCL and Concrete Syntax

Prof. Dr. Joel Greenyer

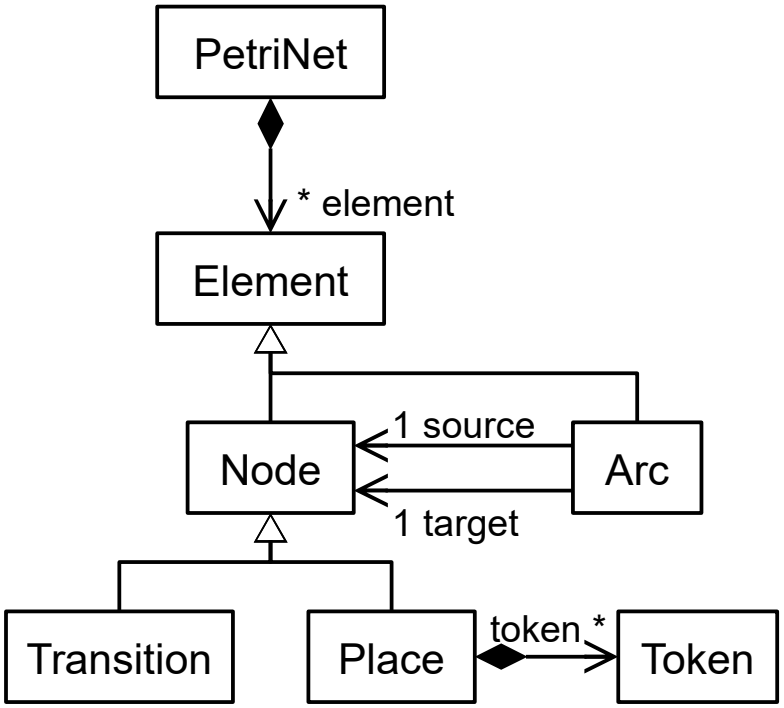
April 26, 2016

SOFTWARE ENGINEERING

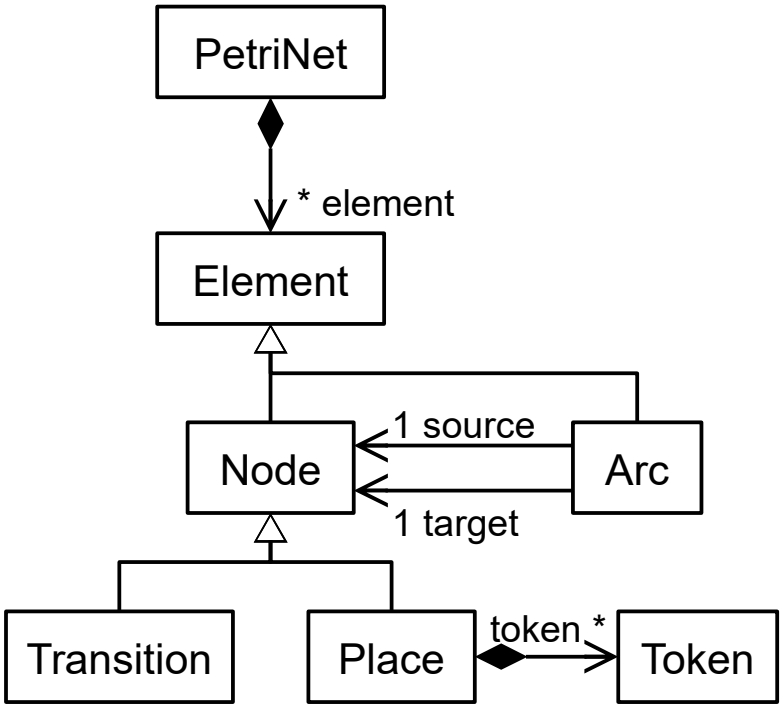
3.1. Introduction to OCL

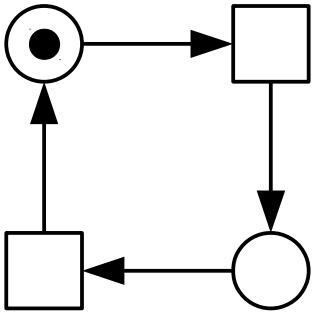
Leibniz Universität Hannover

What's missing?

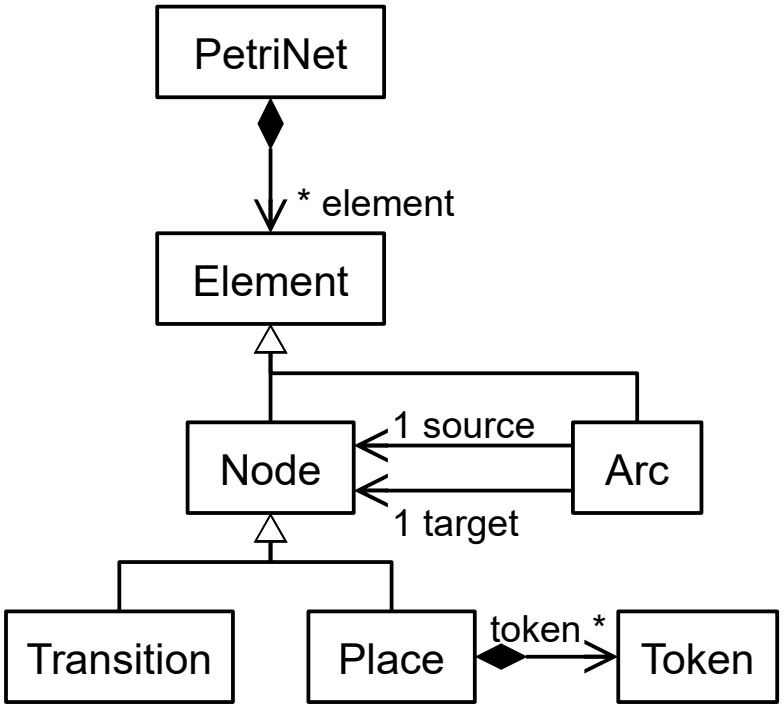


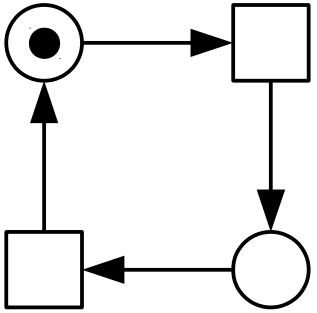
What's missing?

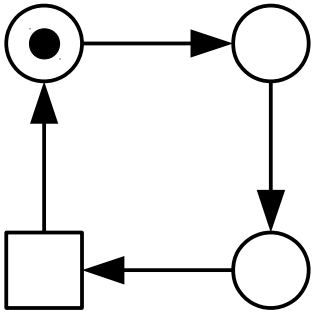




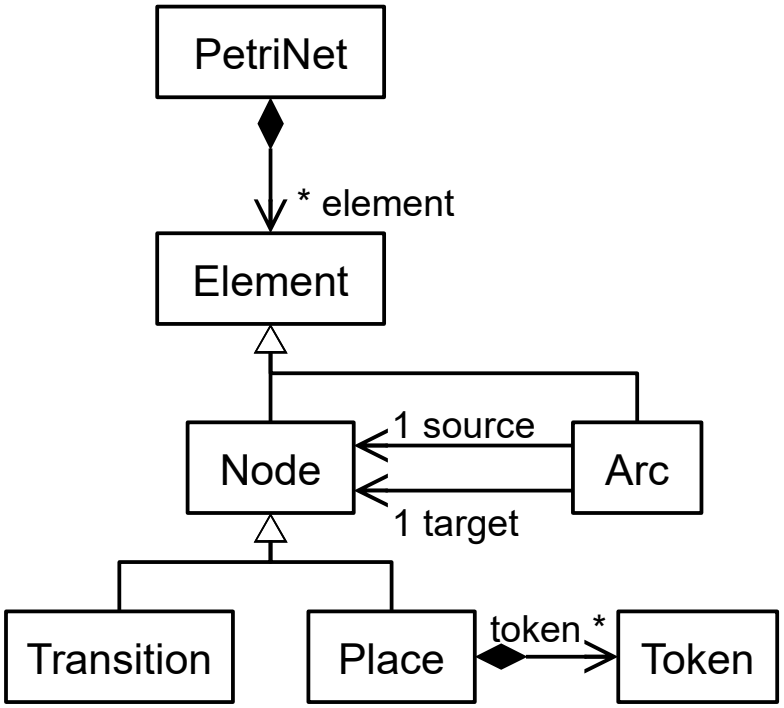
What's missing?

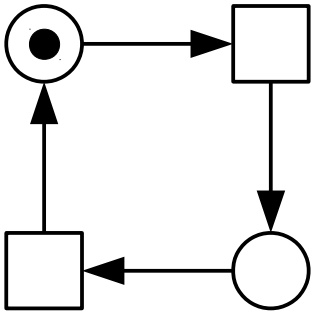


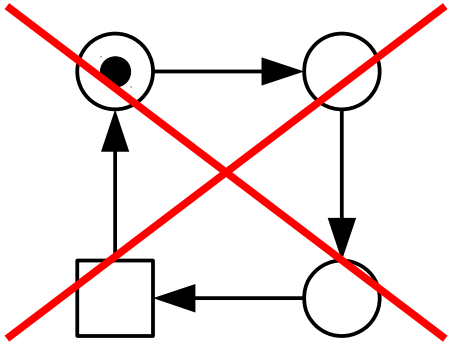




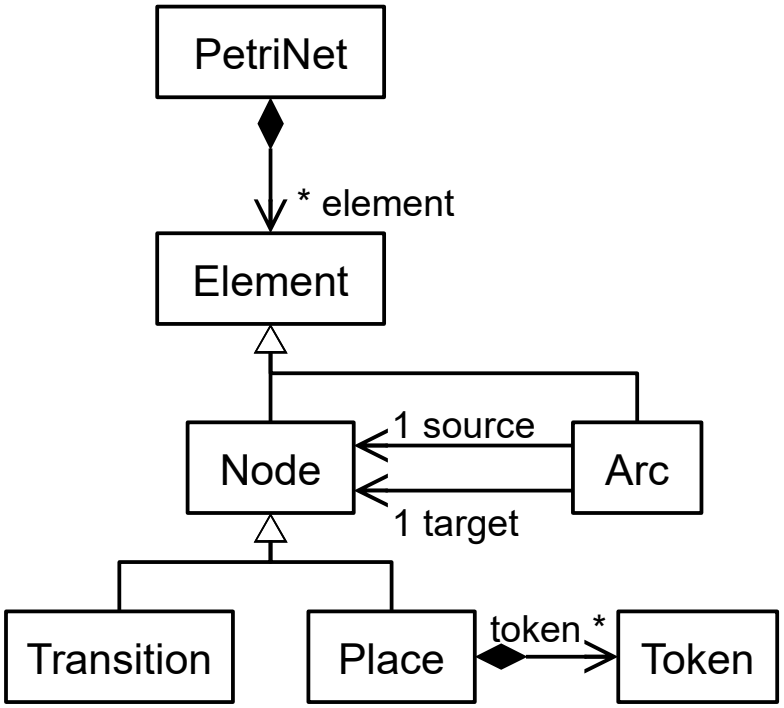
What's missing?

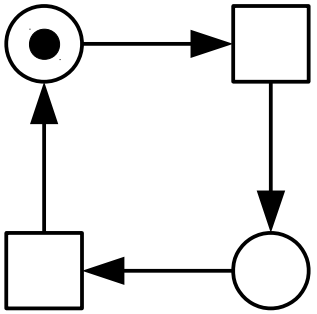


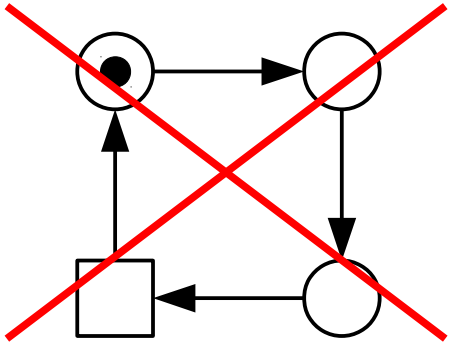




What's missing?

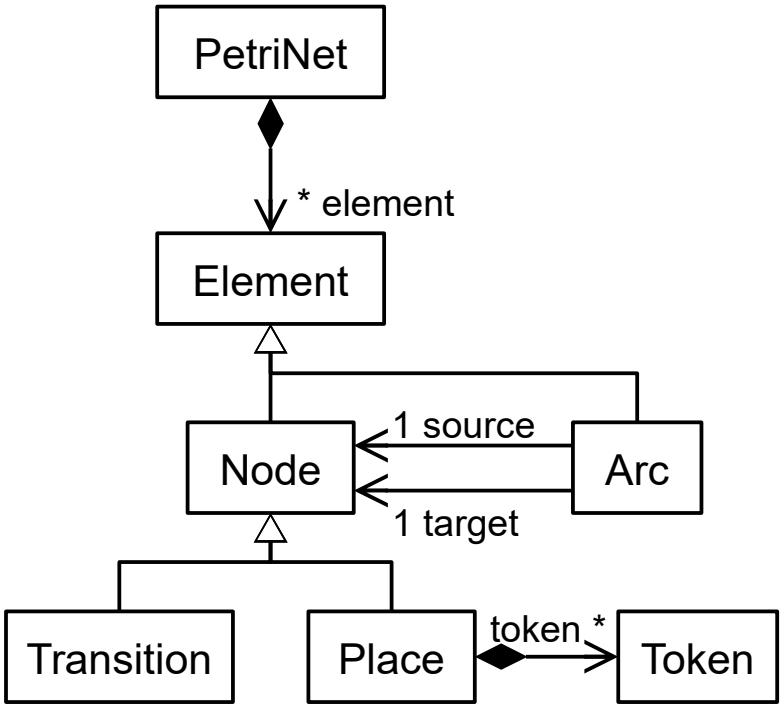


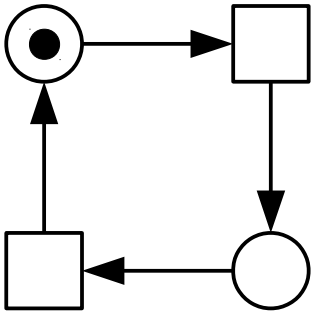


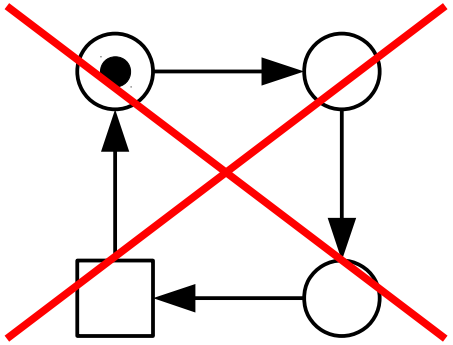


That is not a valid Petri net!: An Arc must only connect Places to Transitions or Transitions for Places

What's missing?



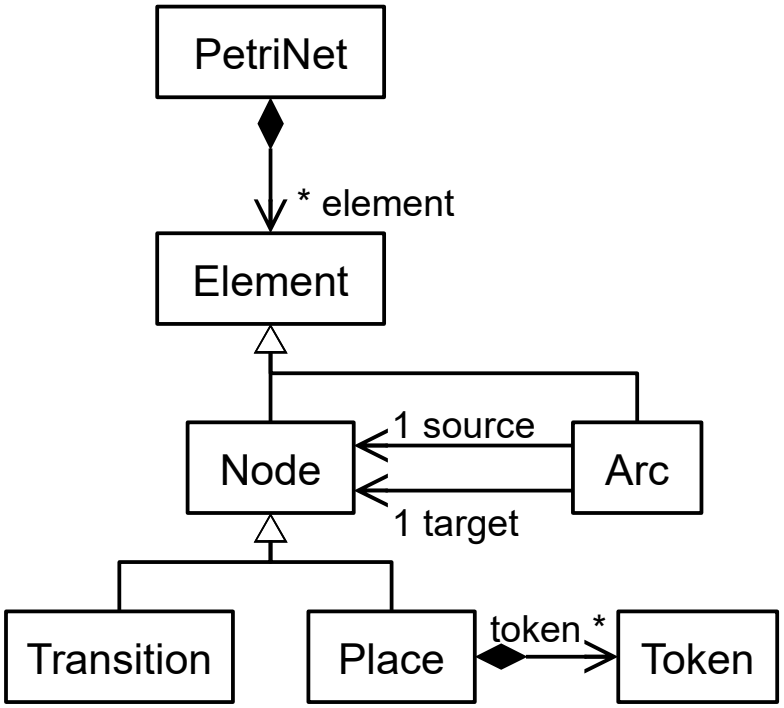


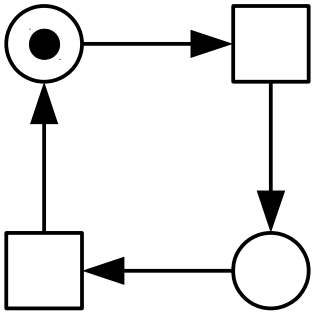


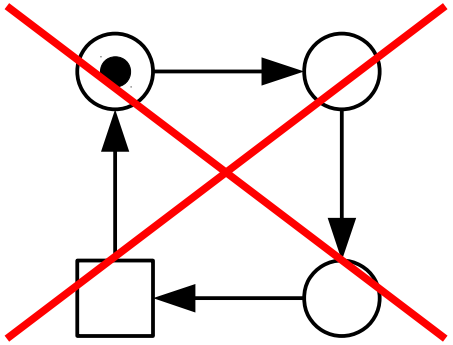
Obviously something is missing in the Petri net metamodel!

That is not a valid Petri net!: An Arc must only connect Places to Transitions or Transitions for Places

What's missing?



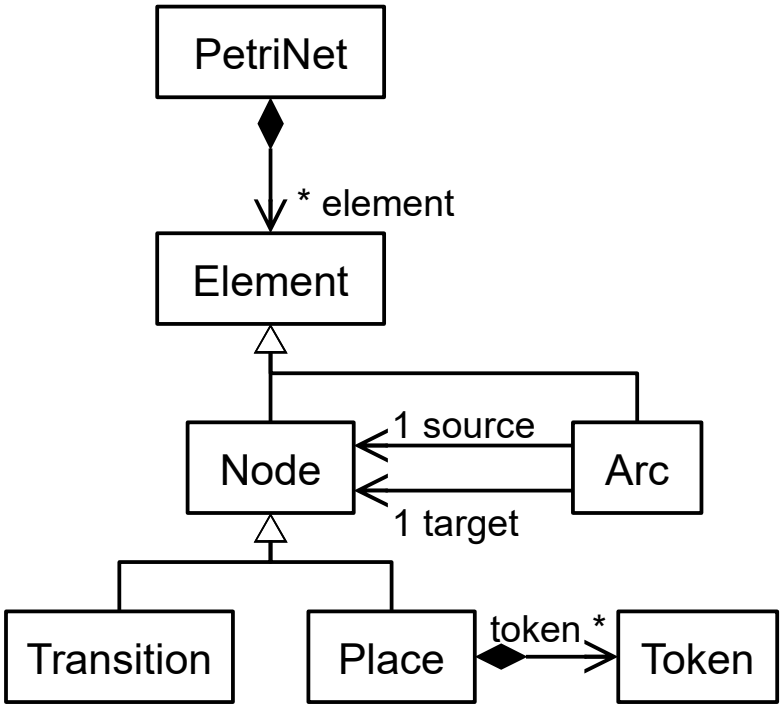




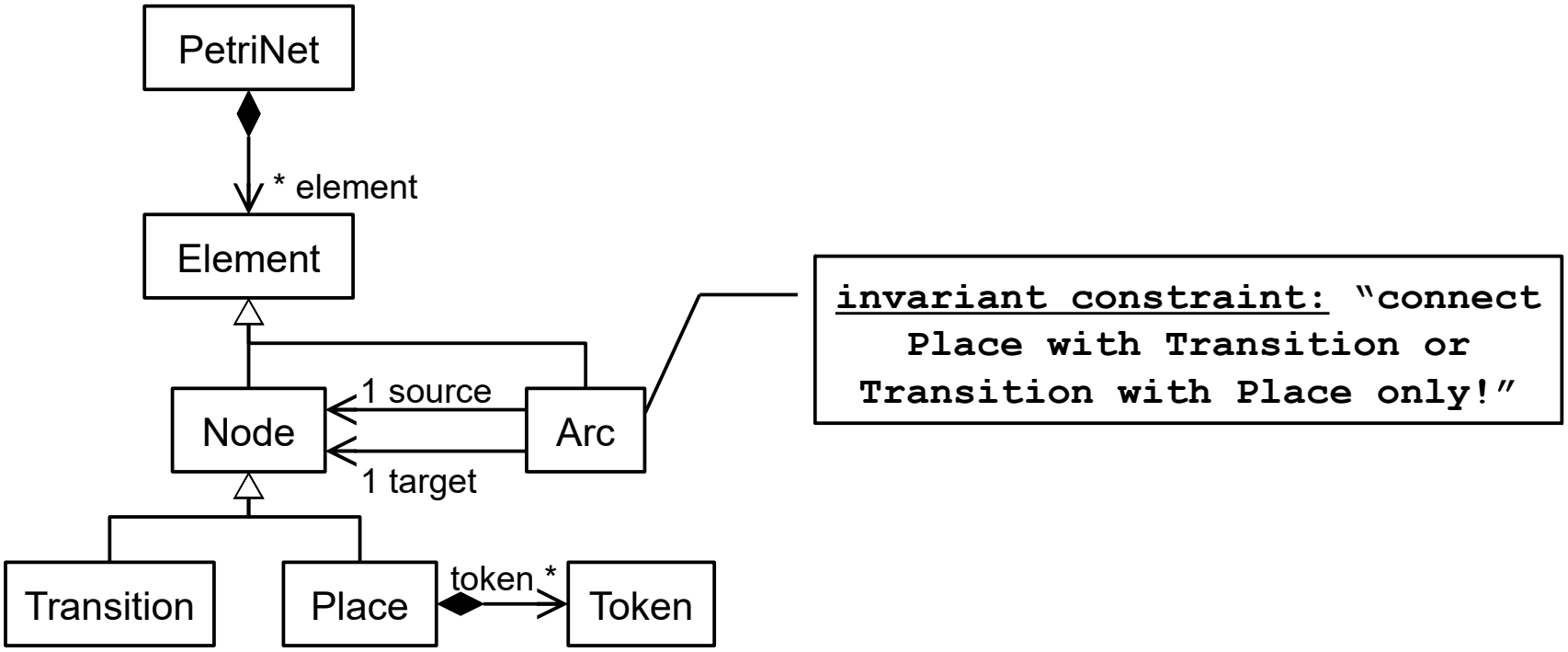
Obviously something is missing in the Petri net metamodel!

That is not a valid Petri net!: An Arc must only connect Places to Transitions or Transitions for Places

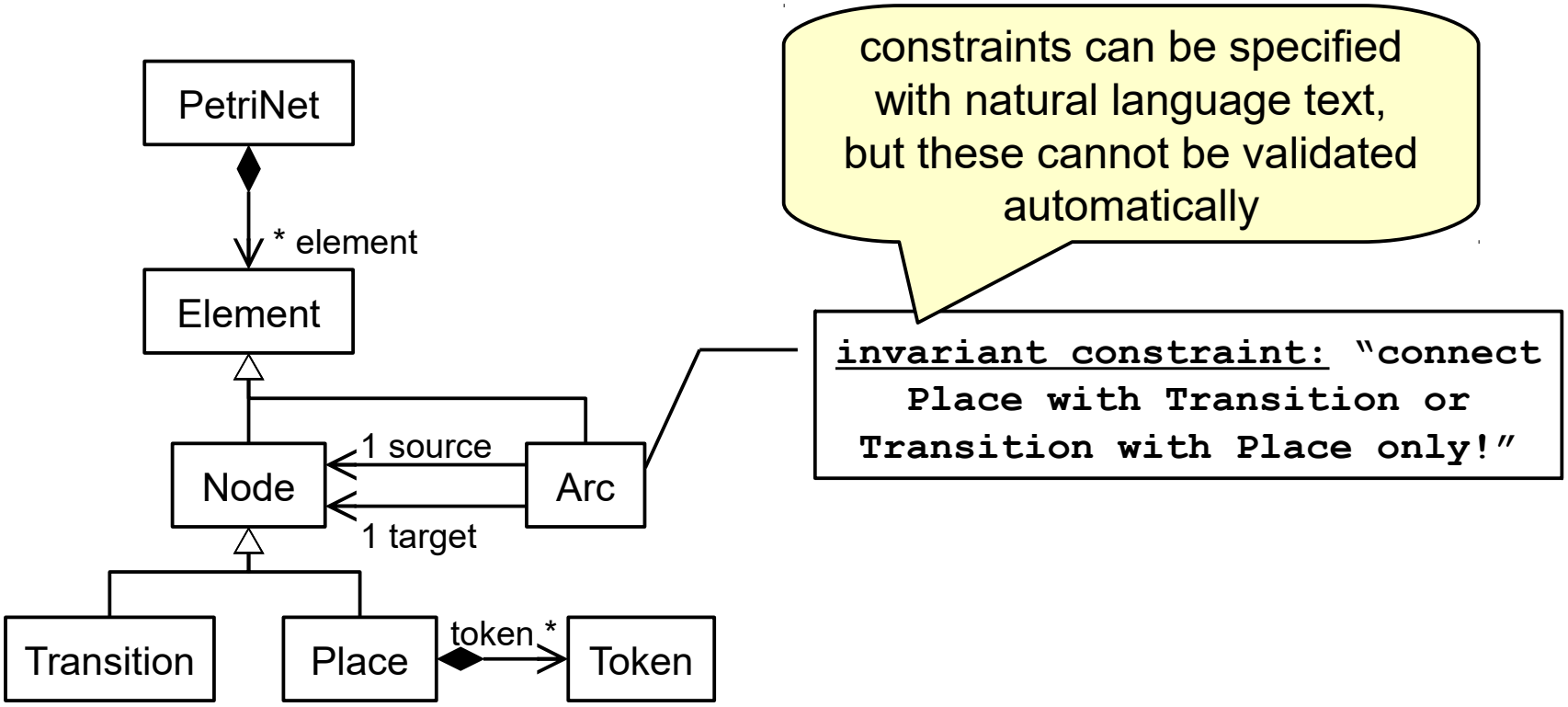
What's missing?



What's missing?



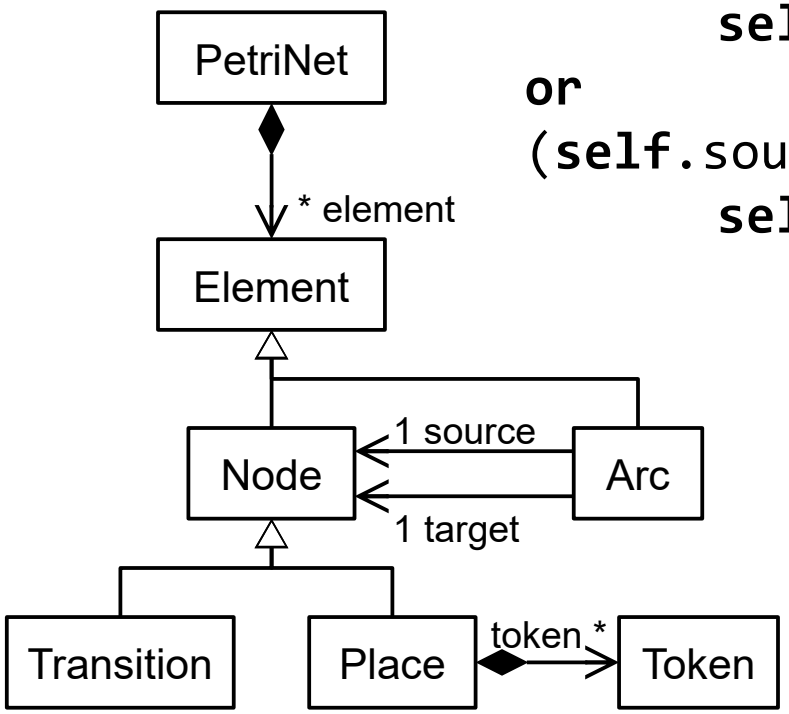
What's missing?



OCL – Example

- Invariant constraint written in the **Object Constraint Language (OCL):**

```
context Arc
inv “No Arcs Between Nodes Of The Same Kind”:
((self.source.oclIsKindOf(Place) and
        self.target.oclIsKindOf(Transition))
or
(self.source.oclIsKindOf(Transition) and
        self.target.oclIsKindOf(Place) ) );
```



OCL – Example

- The **Object Constraint Language (OCL)** is a formal textual language that allows us to specify **constraints** and **queries** on models with a MOF-style metamodel (UML, MOF, ...)
  - OMG standard: http://www.omg.org/spec/OCL/

OCL – Example

- The **Object Constraint Language (OCL)** is a formal textual language that allows us to specify **constraints** and **queries** on models with a MOF-style metamodel (UML, MOF, ...)
  - OMG standard: http://www.omg.org/spec/OCL/

- The OCL language and an interpreter are also implemented for EMF

OCL – Example

- The **Object Constraint Language (OCL)** is a formal textual language that allows us to specify **constraints** and **queries** on models with a MOF-style metamodel (UML, MOF, ...)
  - OMG standard: http://www.omg.org/spec/OCL/

- The OCL language and an interpreter are also implemented for EMF

- OCL is used in many other standards to express constraints: MOF, UML, QVT, …

OCL

- The **Object Constraint Language (OCL)** has been developed to achieve the following goals:

SOFTWARE ENGINEERING

OCL

- The **Object Constraint Language (OCL)** has been developed to achieve the following goals:
  - to be formal, precise, unambiguous

OCL

- The **Object Constraint Language (OCL)** has been developed to achieve the following goals:
  - to be formal, precise, unambiguous
  - to be applicable for a large number of users (business or system modeler, programmers)

OCL

- The **Object Constraint Language (OCL)** has been developed to achieve the following goals:
  - to be formal, precise, unambiguous
  - to be applicable for a large number of users (business or system modeler, programmers)
  - to be a constraint and query language, not a programming language

OCL

- The **Object Constraint Language (OCL)** has been developed to achieve the following goals:
  - to be formal, precise, unambiguous
  - to be applicable for a large number of users (business or system modeler, programmers)
  - to be a constraint and query language, not a programming language
  - to be tool supported

OCL

- OCL constraints and queries have **no side-effects**

SOFTWARE ENGINEERING

OCL

- OCL constraints and queries have **no side-effects**
- The **evaluation** of an OCL expression **returns a value**

OCL

- OCL constraints and queries have **no side-effects**
- The **evaluation** of an OCL expression **returns a value**
  - multiple **types** are supported: we get to them shortly

OCL

- OCL constraints and queries have **no side-effects**
- The **evaluation** of an OCL expression **returns a value**
  - multiple **types** are supported: we get to them shortly
  - When an **invariant constraint: Boolean**

SOFTWARE ENGINEERING

OCL

- OCL constraints and queries have **no side-effects**
- The **evaluation** of an OCL expression **returns a value**
  - multiple **types** are supported: we get to them shortly
  - When an **invariant constraint: Boolean**
- OCL is **not a programming language**

SOFTWARE ENGINEERING

OCL

- OCL constraints and queries have **no side-effects**
- The **evaluation** of an OCL expression **returns a value**
  - multiple **types** are supported: we get to them shortly
  - When an **invariant constraint: Boolean**
- OCL is **not a programming language**
  - no program logic or flow control

OCL

- OCL constraints and queries have **no side-effects**
- The **evaluation** of an OCL expression **returns a value**
  - multiple **types** are supported: we get to them shortly
  - When an **invariant constraint: Boolean**
- OCL is **not a programming language**
  - no program logic or flow control
  - no invocation of processes or activation of non-query operations

SOFTWARE ENGINEERING

OCL

- OCL constraints and queries have **no side-effects**
- The **evaluation** of an OCL expression **returns a value**
  - multiple **types** are supported: we get to them shortly
  - When an **invariant constraint: Boolean**
- OCL is **not a programming language**
  - no program logic or flow control
  - no invocation of processes or activation of non-query operations
- OCL is a **typed language**

OCL

- OCL constraints and queries have **no side-effects**
- The **evaluation** of an OCL expression **returns a value**
  - multiple **types** are supported: we get to them shortly
  - When an **invariant constraint: Boolean**
- OCL is **not a programming language**
  - no program logic or flow control
  - no invocation of processes or activation of non-query operations
- OCL is a **typed language**
  - Each classifier in the model represents a distinct OCL type

OCL

- OCL constraints and queries have **no side-effects**
- The **evaluation** of an OCL expression **returns a value**
  - multiple **types** are supported: we get to them shortly
  - When an **invariant constraint: Boolean**
- OCL is **not a programming language**
  - no program logic or flow control
  - no invocation of processes or activation of non-query operations
- OCL is a **typed language**
  - Each classifier in the model represents a distinct OCL type
    - we can define variables typed over classifiers in the model

OCL

- OCL constraints and queries have **no side-effects**
- The **evaluation** of an OCL expression **returns a value**
  - multiple **types** are supported: we get to them shortly
  - When an **invariant constraint: Boolean**
- OCL is **not a programming language**
  - no program logic or flow control
  - no invocation of processes or activation of non-query operations
- OCL is a **typed language**
  - Each classifier in the model represents a distinct OCL type
    - we can define variables typed over classifiers in the model
  - Includes a set of predefined types

OCL

- OCL can be used

OCL

- OCL can be used
  - as a **query language**

SOFTWARE ENGINEERING

OCL

- OCL can be used
  - as a **query language**
  - to **specify invariants** on classes and types in a class model

SOFTWARE ENGINEERING

OCL

- OCL can be used
  - as a **query language**
  - to **specify invariants** on classes and types in a class model
  - to describe **pre- and post conditions** on operations

OCL

- OCL can be used
  - as a **query language**
  - to **specify invariants** on classes and types in a class model
  - to describe **pre- and post conditions** on operations
  - to describe **guards** (in UML behavior models)

OCL

- OCL can be used
  - as a **query language**
  - to **specify invariants** on classes and types in a class model
  - to describe **pre- and post conditions** on operations
  - to describe **guards** (in UML behavior models)
  - to specify **derivation rules** for **derived features** (attributes or references/associations)

OCL

- Each OCL expression is related to an object, the instance of a class

OCL

- Each OCL expression is related to an object, the instance of a class
  - A **context declaration** is used to determine the class

OCL

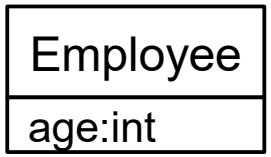
- Each OCL expression is related to an object, the instance of a class
  - A **context declaration** is used to determine the class
- `self` refers to the contextual instance

OCL

- Each OCL expression is related to an object, the instance of a class
  - A **context declaration** is used to determine the class
- `self` refers to the contextual instance
- Example:

OCL

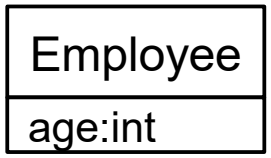
- Each OCL expression is related to an object, the instance of a class
  - A **context declaration** is used to determine the class
- **`self`** refers to the contextual instance
- Example:




```
context Employee
inv: self.age >= 19
```

OCL

- Each OCL expression is related to an object, the instance of a class
  - A **context declaration** is used to determine the class
- **`self`** refers to the contextual instance
- Example:

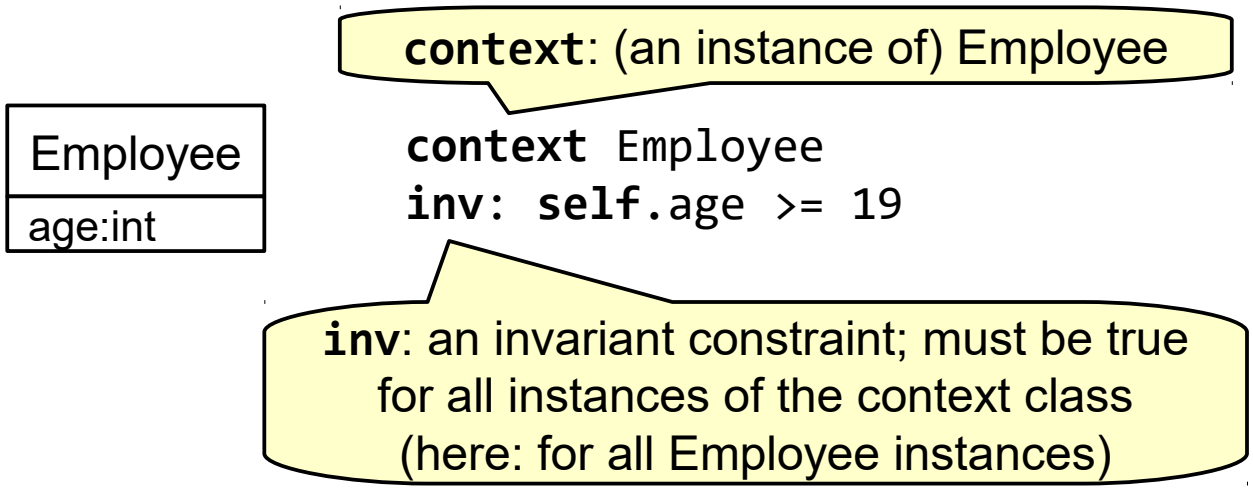


`context`: (an instance of) Employee

```
context Employee
inv: self.age >= 19
```

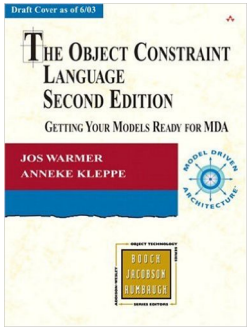
OCL

- Each OCL expression is related to an object, the instance of a class
  - A **context declaration** is used to determine the class
- **`self`** refers to the contextual instance
- Example:



Resources

- Jordi Cabot, Martin Gogolla: Object Constraint Language (OCL): A Definitive Guide, in Formal Methods for Model-Driven Engineering, Volume 7320 of Lecture Notes in Computer Science, pp 58-90, 2012.
  - http://link.springer.com/chapter/10.1007%2F978-3-642-30982-3_3
  - http://modeling-languages.com/wp-content/uploads/2012/03/OCLChapter.pdf
- Jos Warmer, Anneke Kleppe: The Object Constraint Language: Getting Your Models Ready for MDA, Addison-Wesley Professional; 2nd edition, 2003.



- Christian Hein, A presentation of OCL 2, Open Model CourseWare, 2006
  - https://eclipse.org/gmt/omcw/resources/chapter01/downloads/OCL2.Fraunhofer.ppt

SOFTWARE ENGINEERING

3.2. OCL types

Leibniz Universität Hannover

SOFTWARE ENGINEERING

OCL Types

- OCL is a typed language

SOFTWARE ENGINEERING

OCL Types

- OCL is a typed language
  - queries evaluate to values of certain types

OCL Types

- OCL is a typed language
  - queries evaluate to values of certain types
  - we can work with variables of certain types

SOFTWARE ENGINEERING

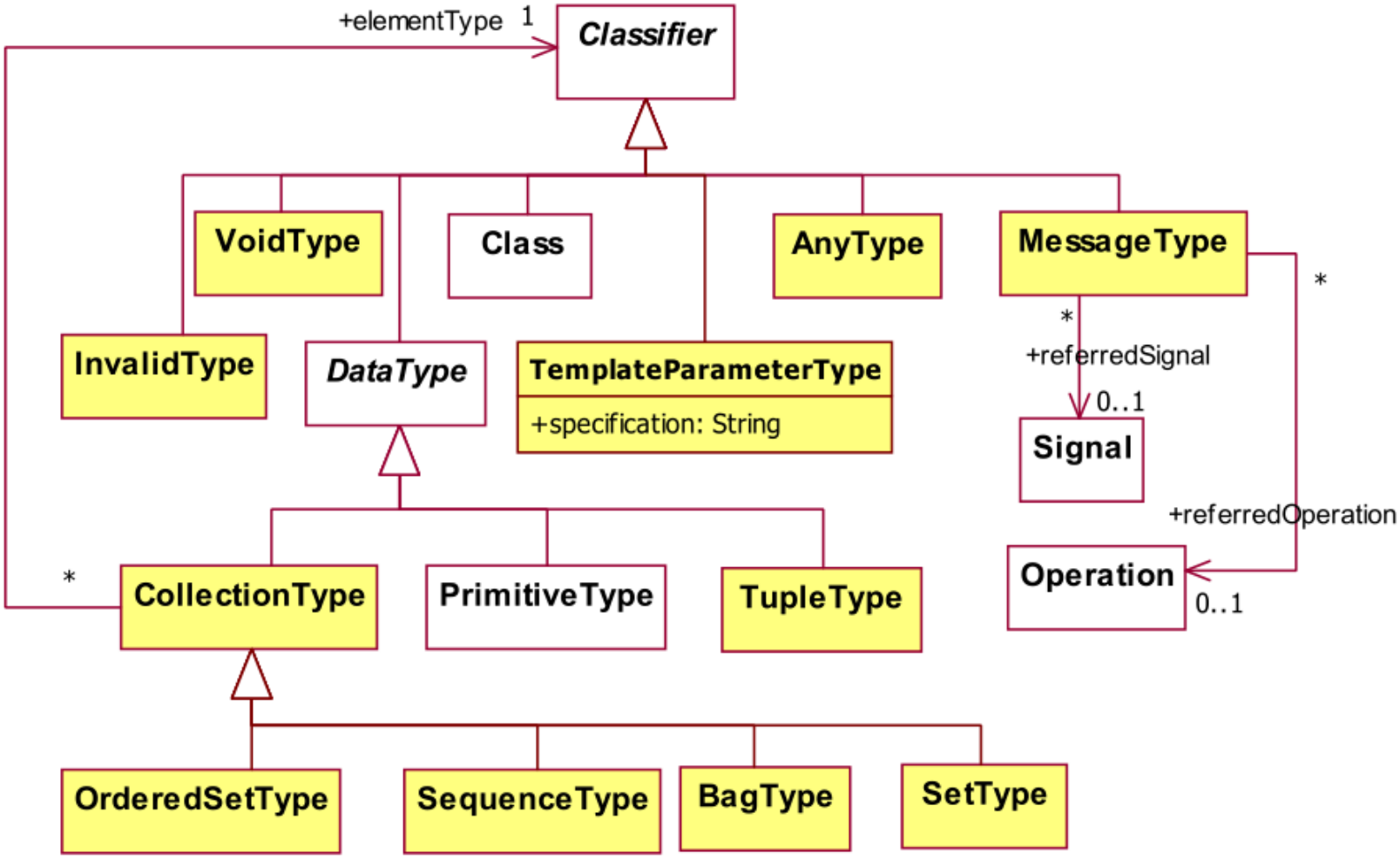
OCL Types

- OCL is a typed language
  - queries evaluate to values of certain types
  - we can work with variables of certain types
  - different types offer different functions

OCL Types

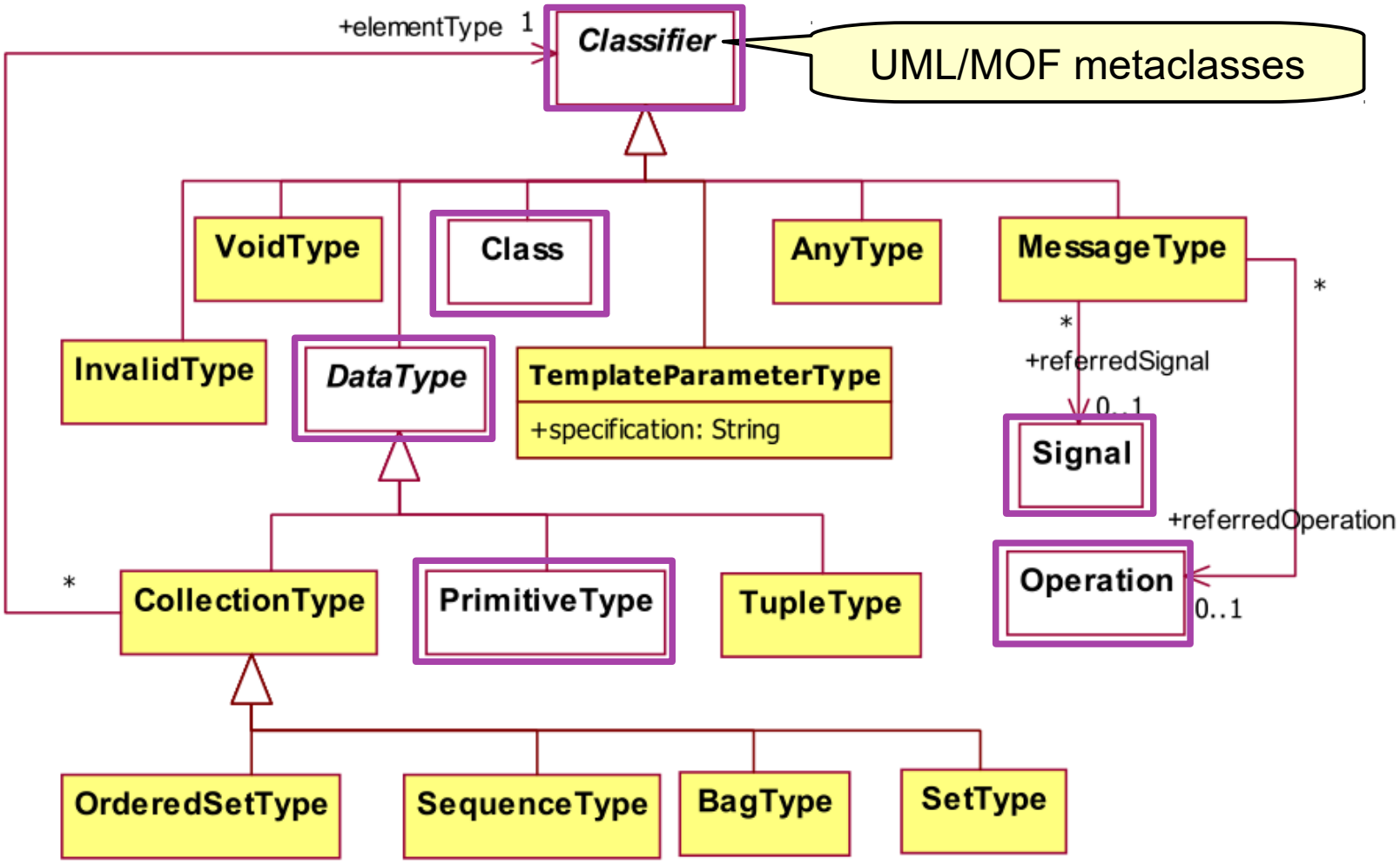
- OCL is a typed language
  - queries evaluate to values of certain types
  - we can work with variables of certain types
  - different types offer different functions
    - for example `collection->forAll(...)`

OCL Types Metamodel



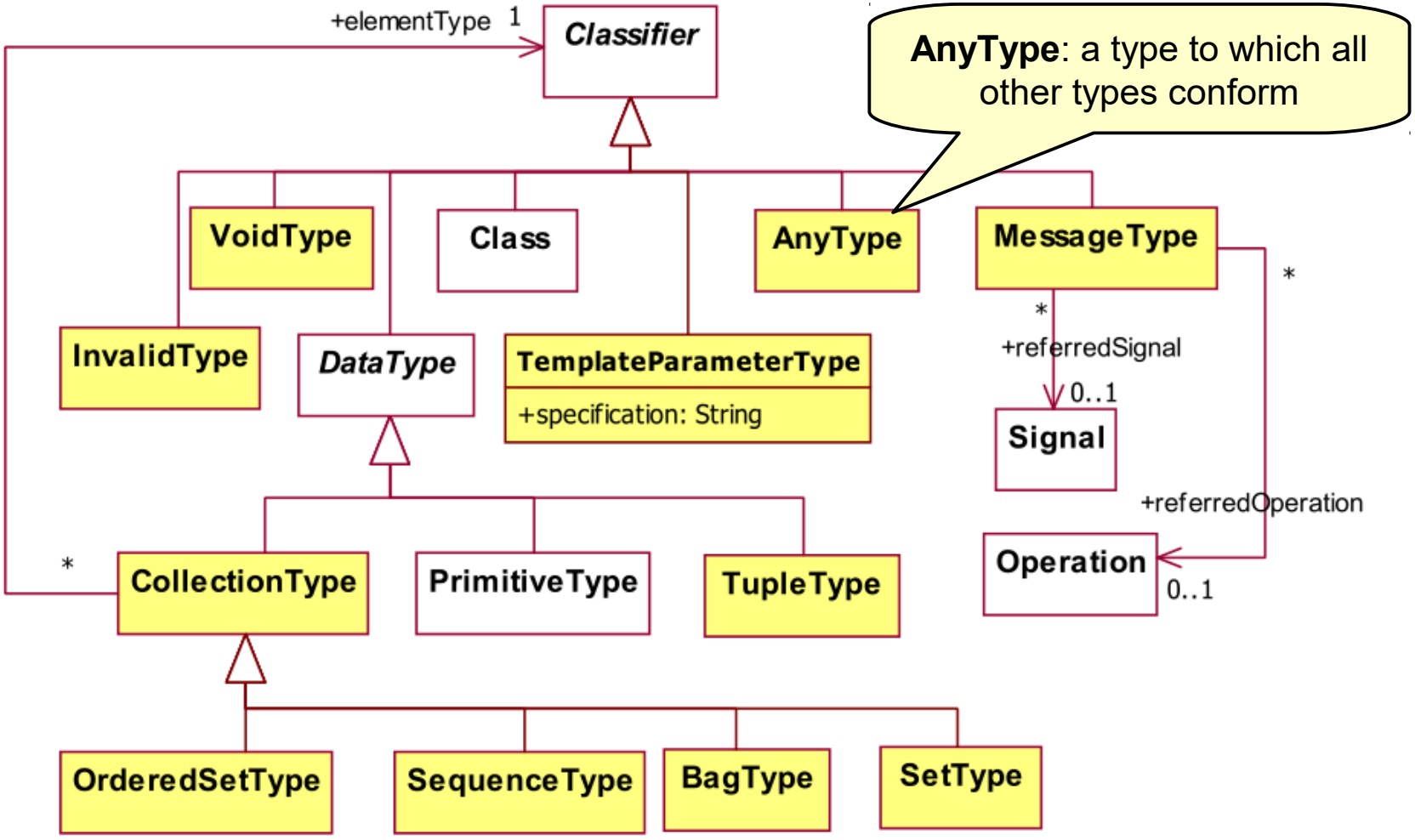
from http://www.omg.org/spec/OCL/2.4/PDF (Figure 8.1)

OCL Types Metamodel



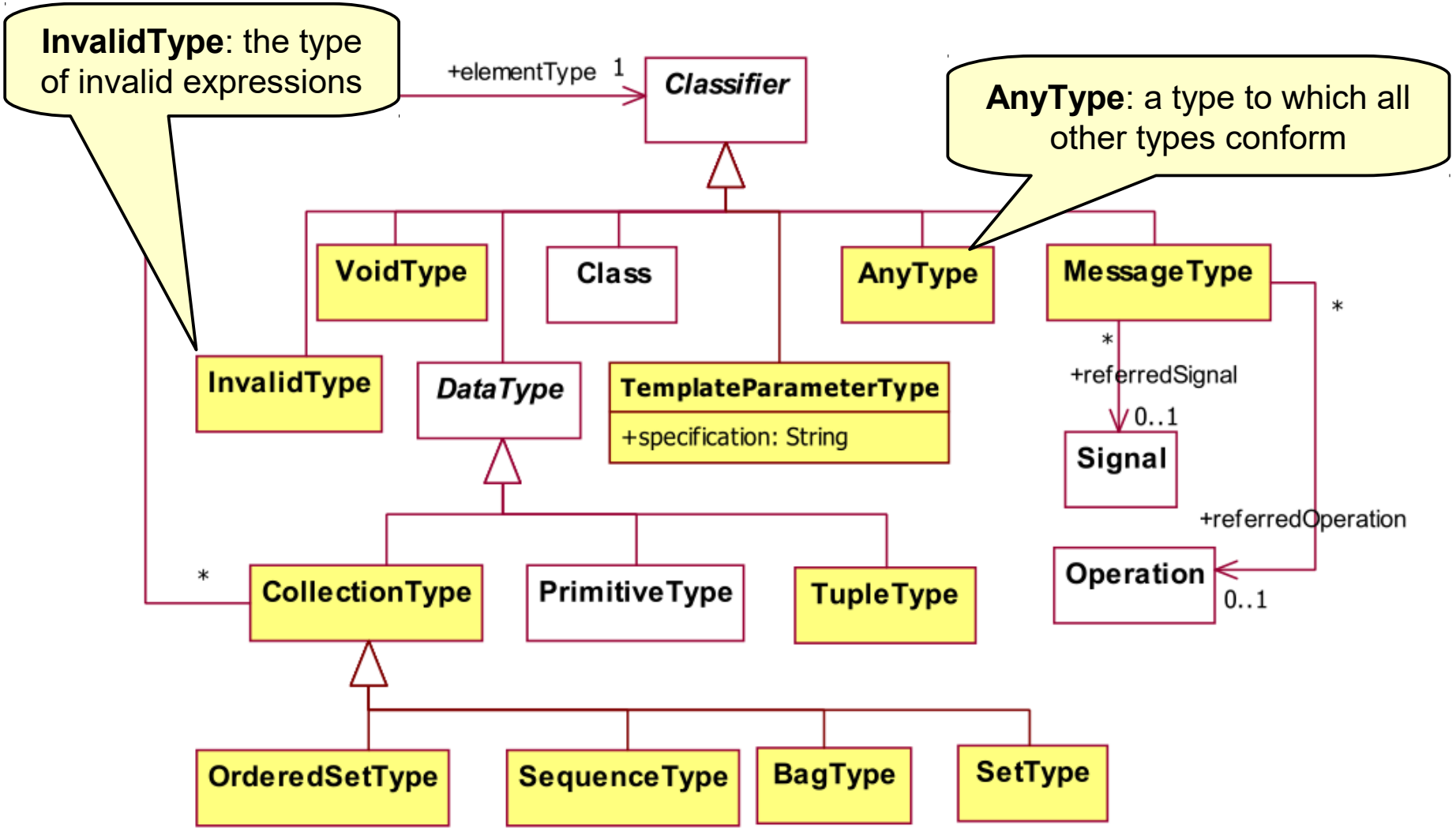
from http://www.omg.org/spec/OCL/2.4/PDF (Figure 8.1)

OCL Types Metamodel



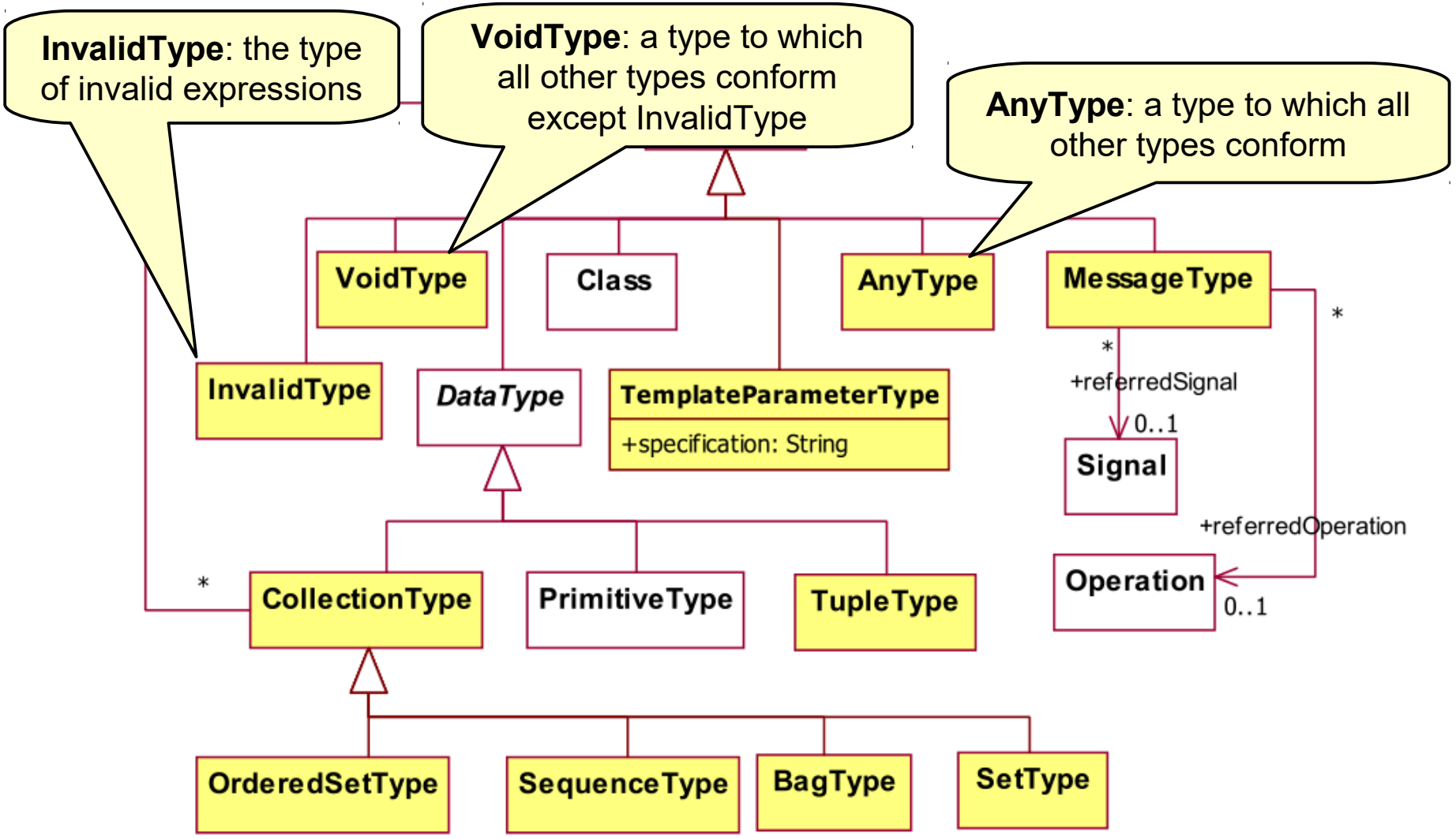
from http://www.omg.org/spec/OCL/2.4/PDF (Figure 8.1)

OCL Types Metamodel



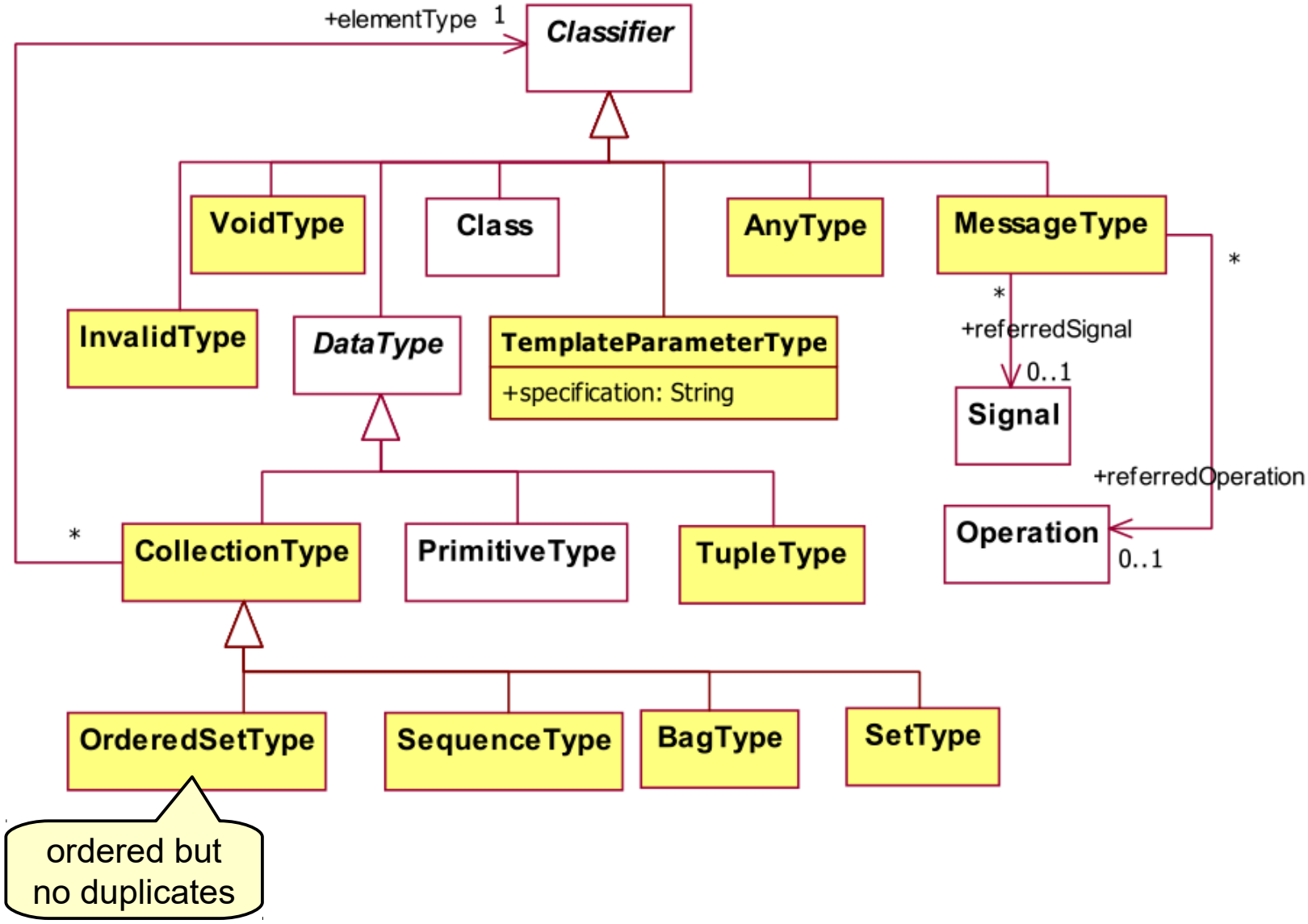
from http://www.omg.org/spec/OCL/2.4/PDF (Figure 8.1)

OCL Types Metamodel

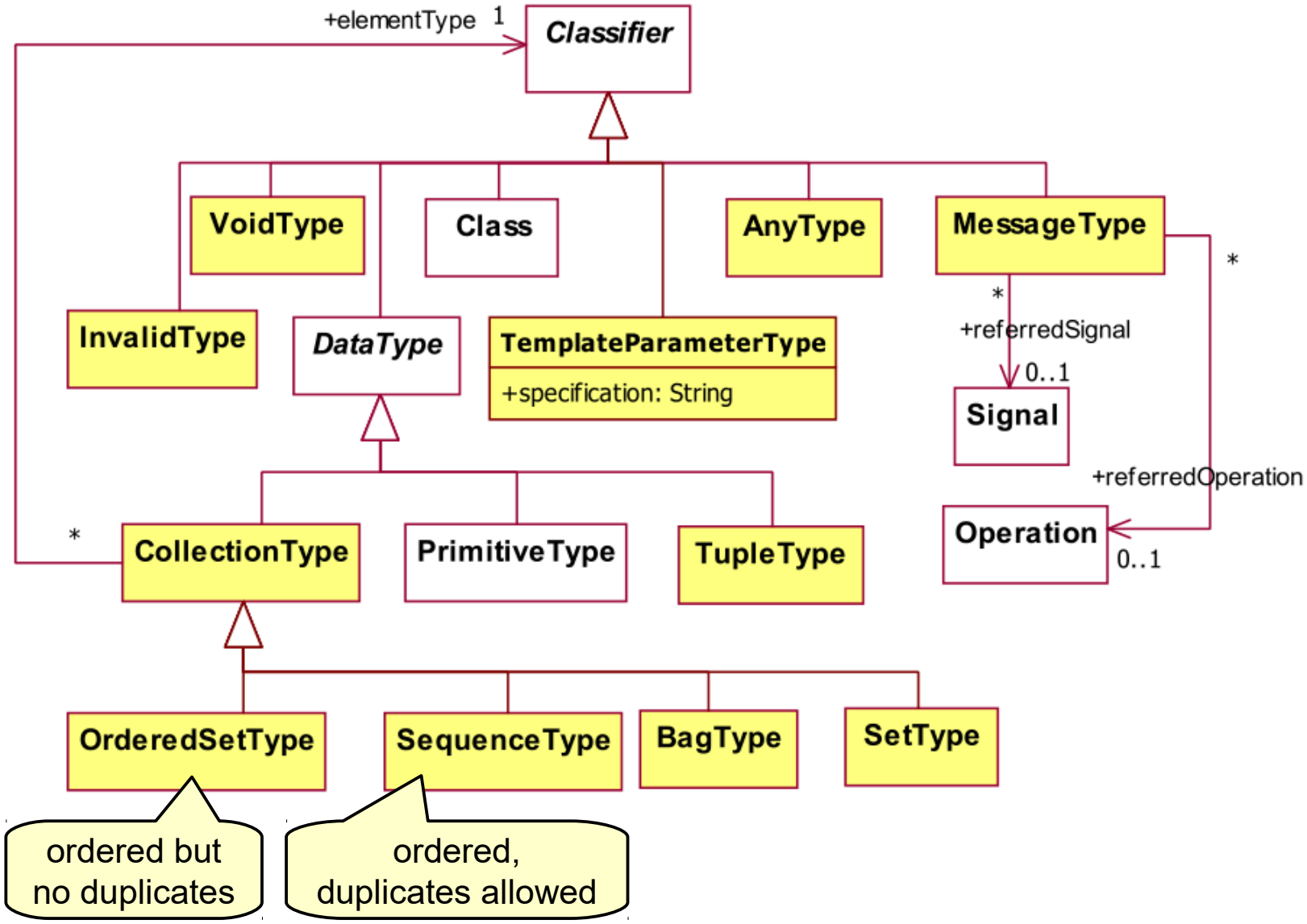


from http://www.omg.org/spec/OCL/2.4/PDF (Figure 8.1)

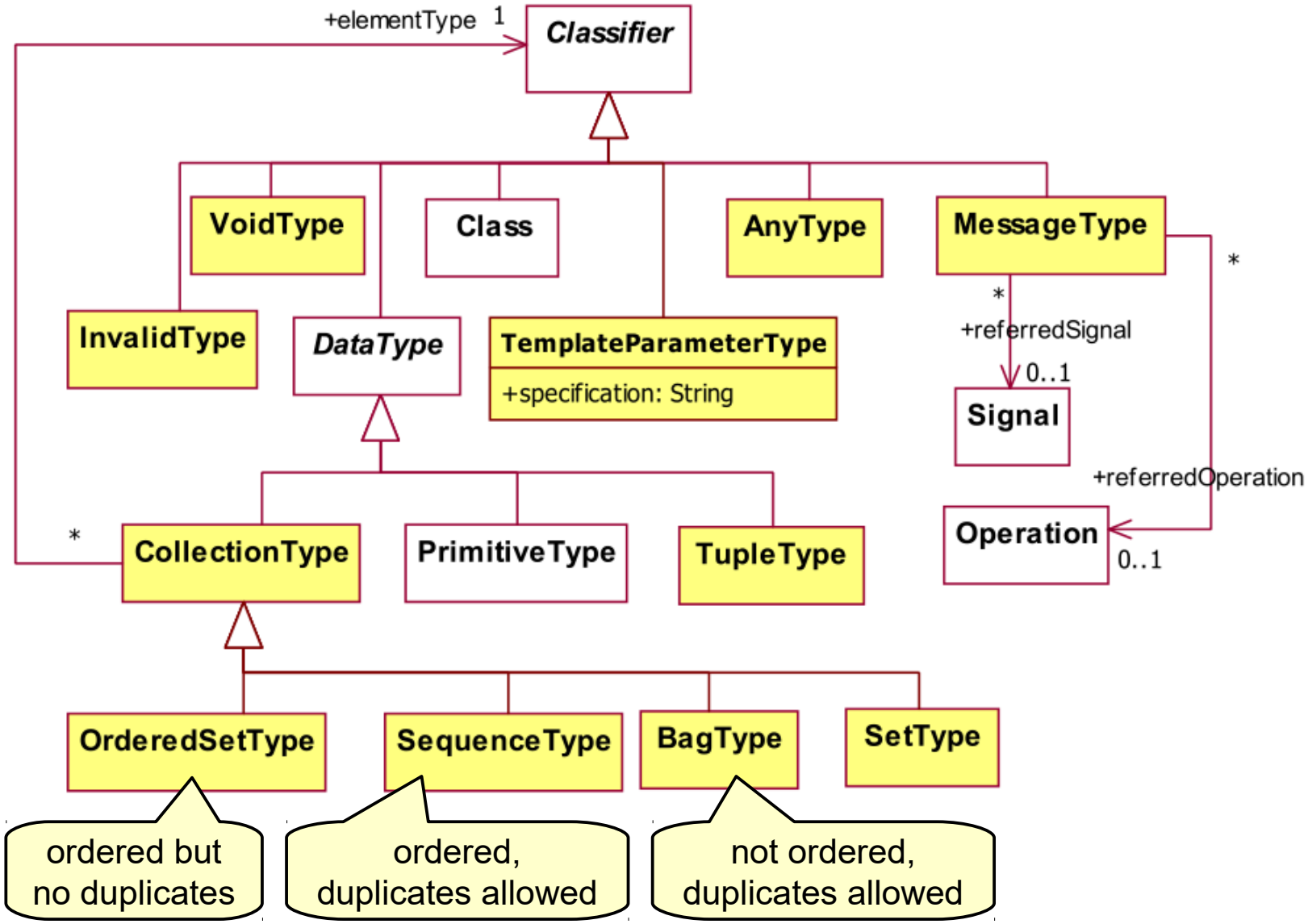
OCL Types Metamodel



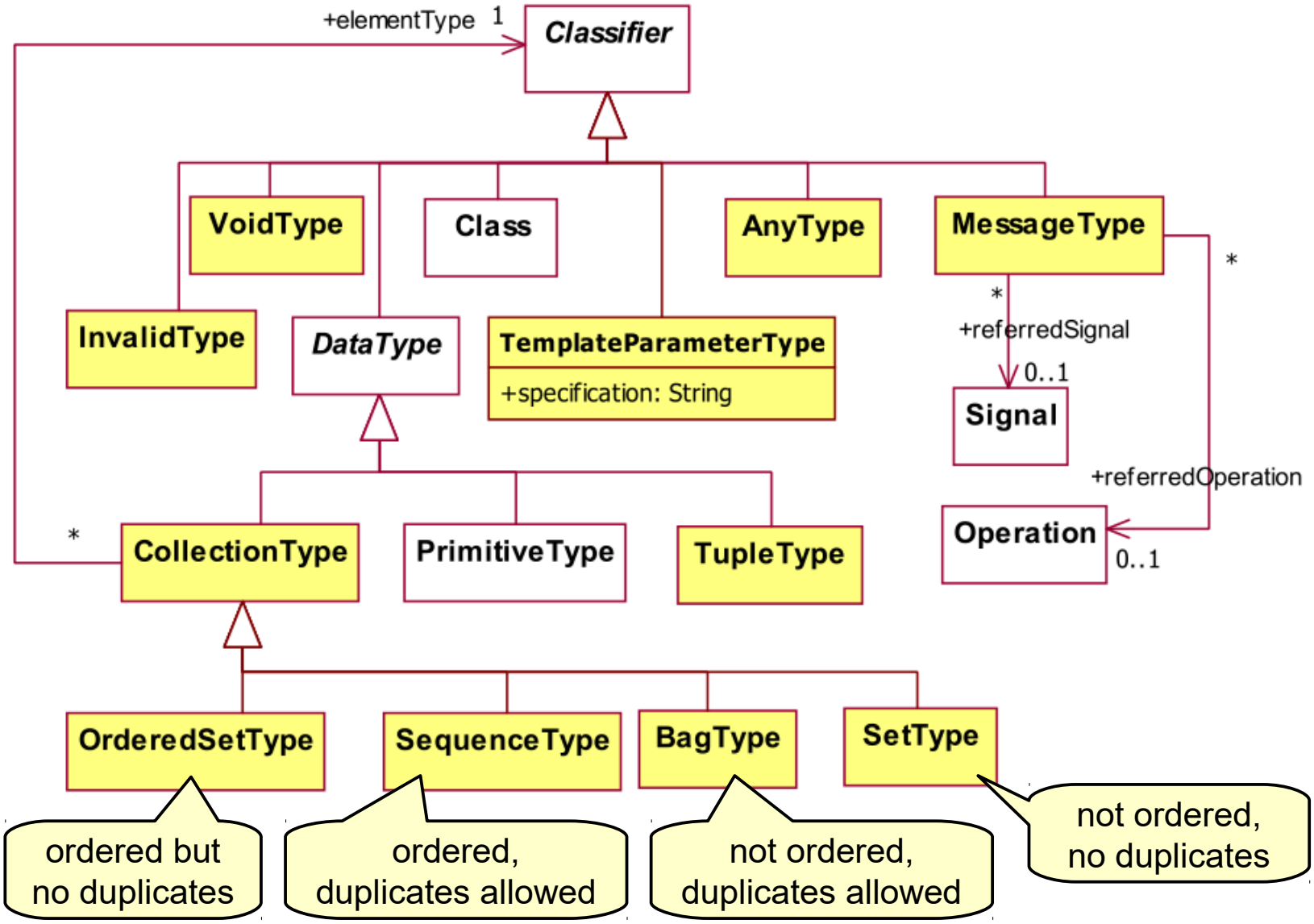
OCL Types Metamodel



OCL Types Metamodel

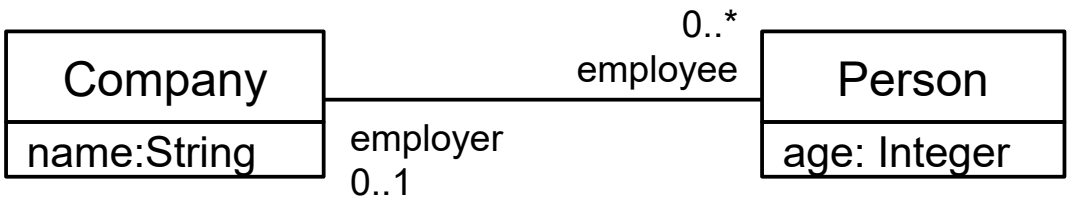


OCL Types Metamodel



Operations on Collection Types

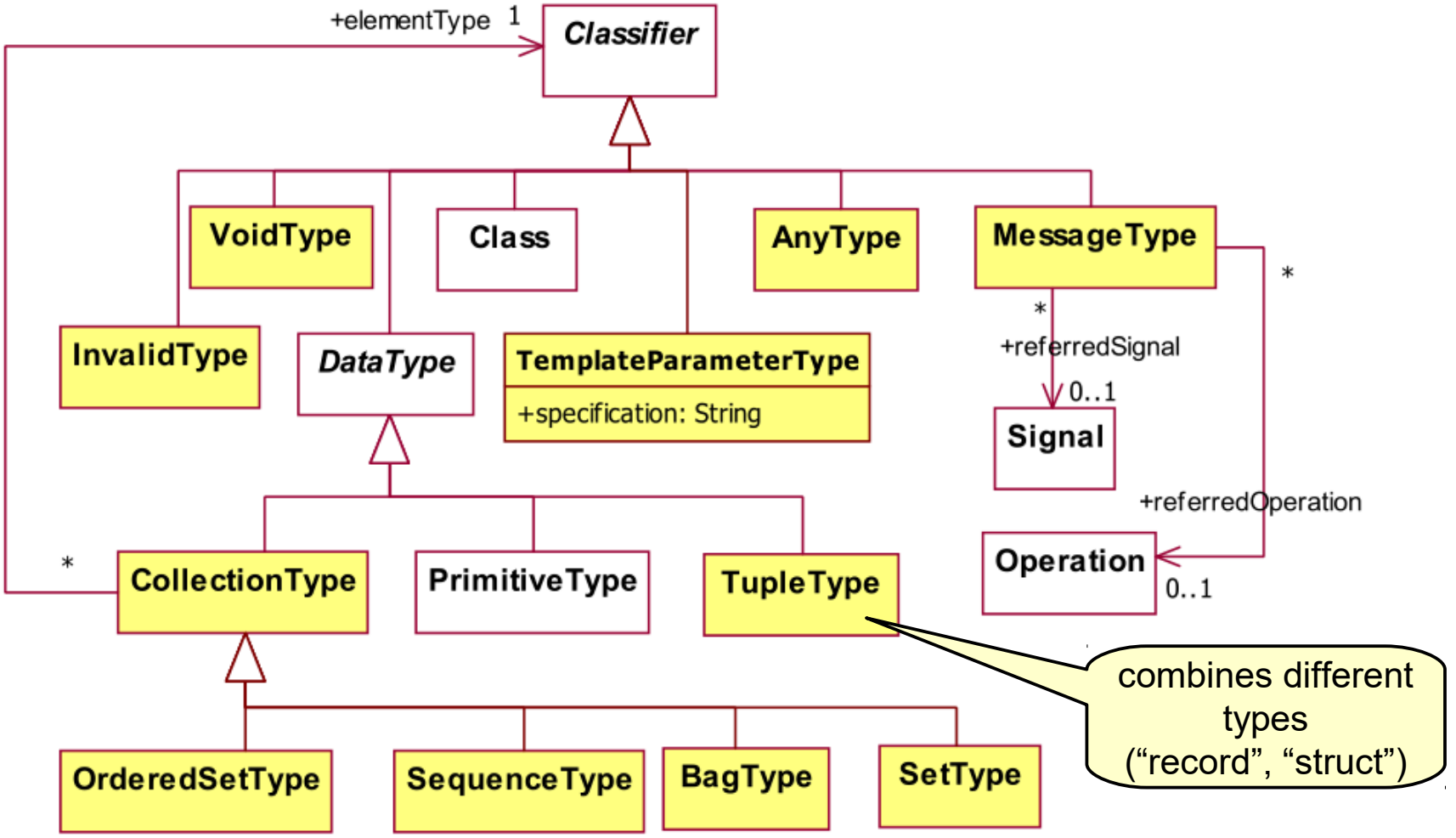
- For example:



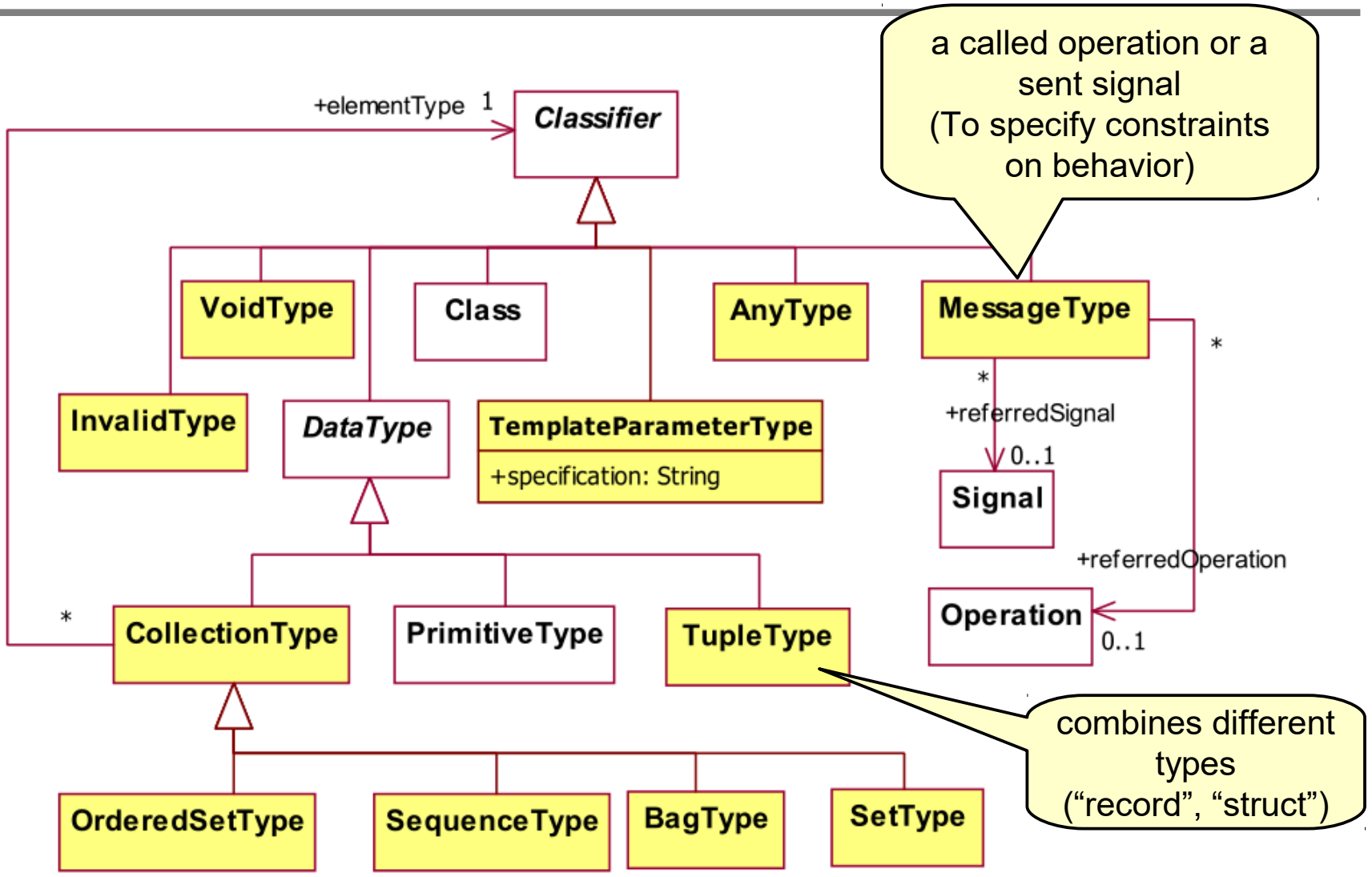

```
context Company
inv:  self.employee->forAll( age <= 65 )
inv:  self.employee->forAll( p | p.age <= 65 )
inv:  self.employee->forAll( p : Person | p.age <= 65 )
```

from http://www.omg.org/spec/OCL/2.4/PDF

OCL Types Metamodel



OCL Types Metamodel

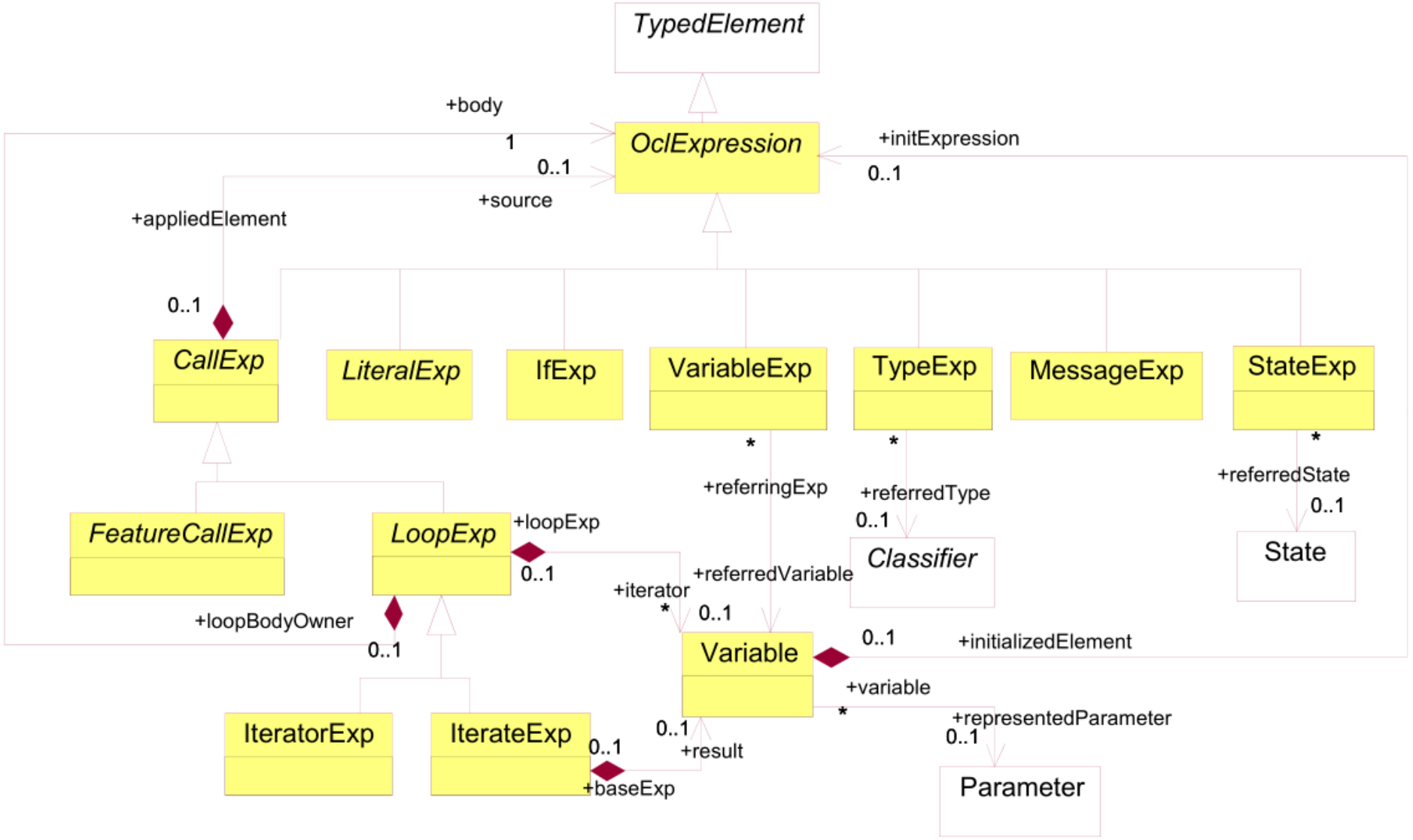


SOFTWARE ENGINEERING

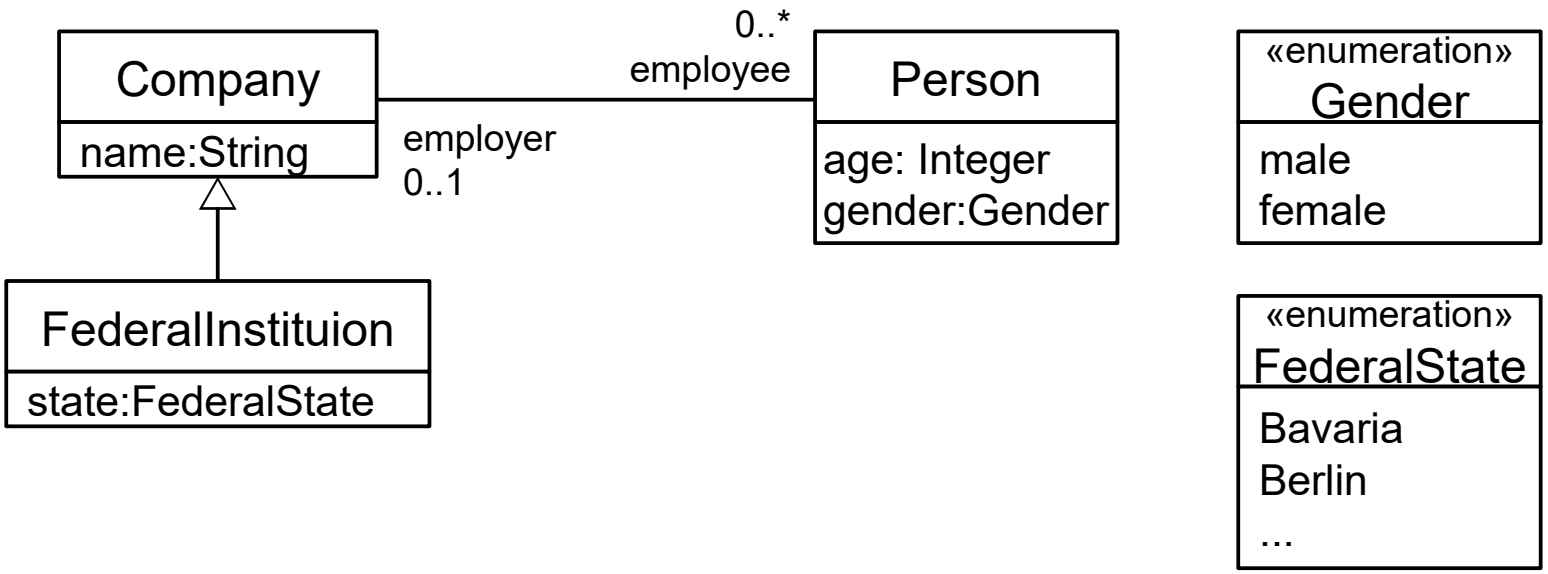
3.2. OCL expressions

Leibniz Universität Hannover

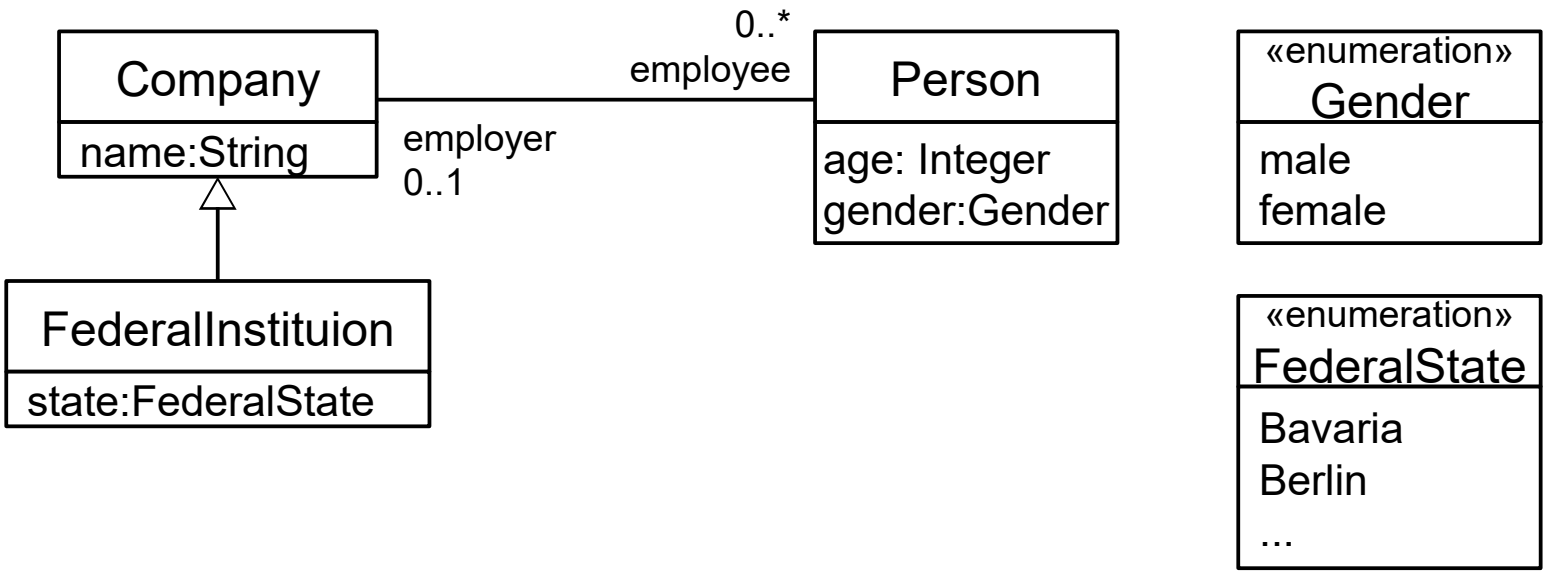
OCL Expressions



Accessing Objects and Properties

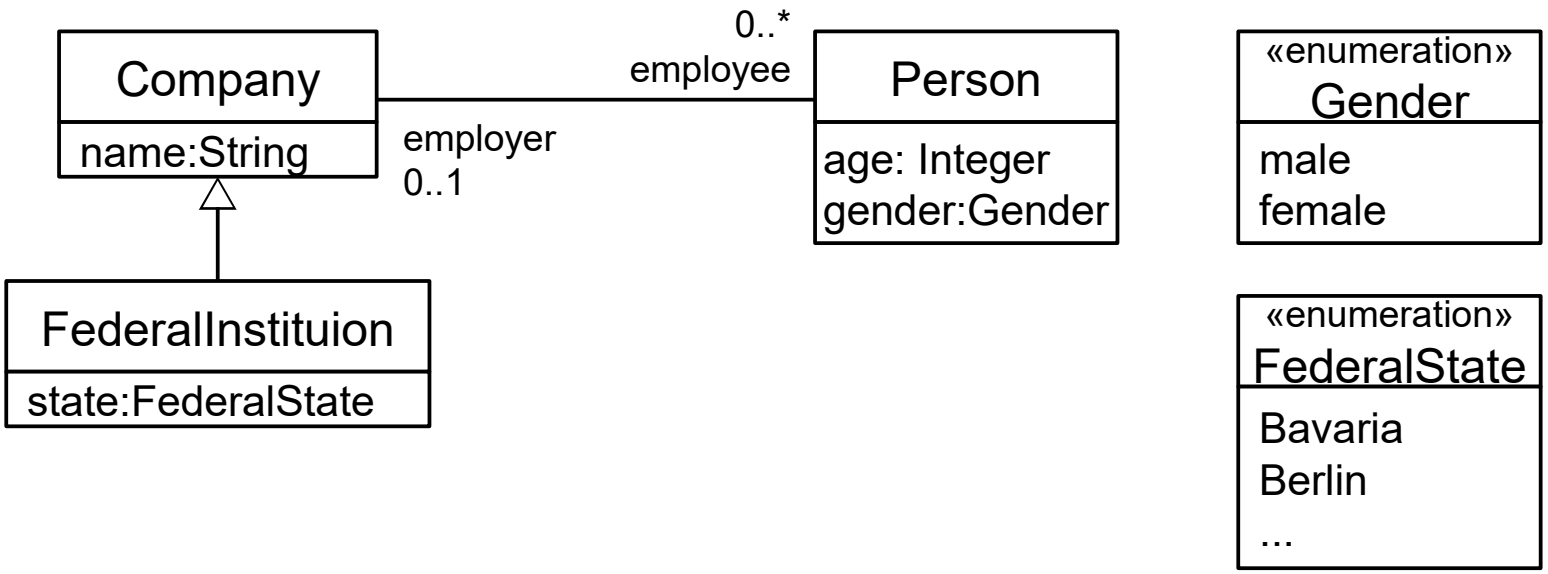


Accessing Objects and Properties



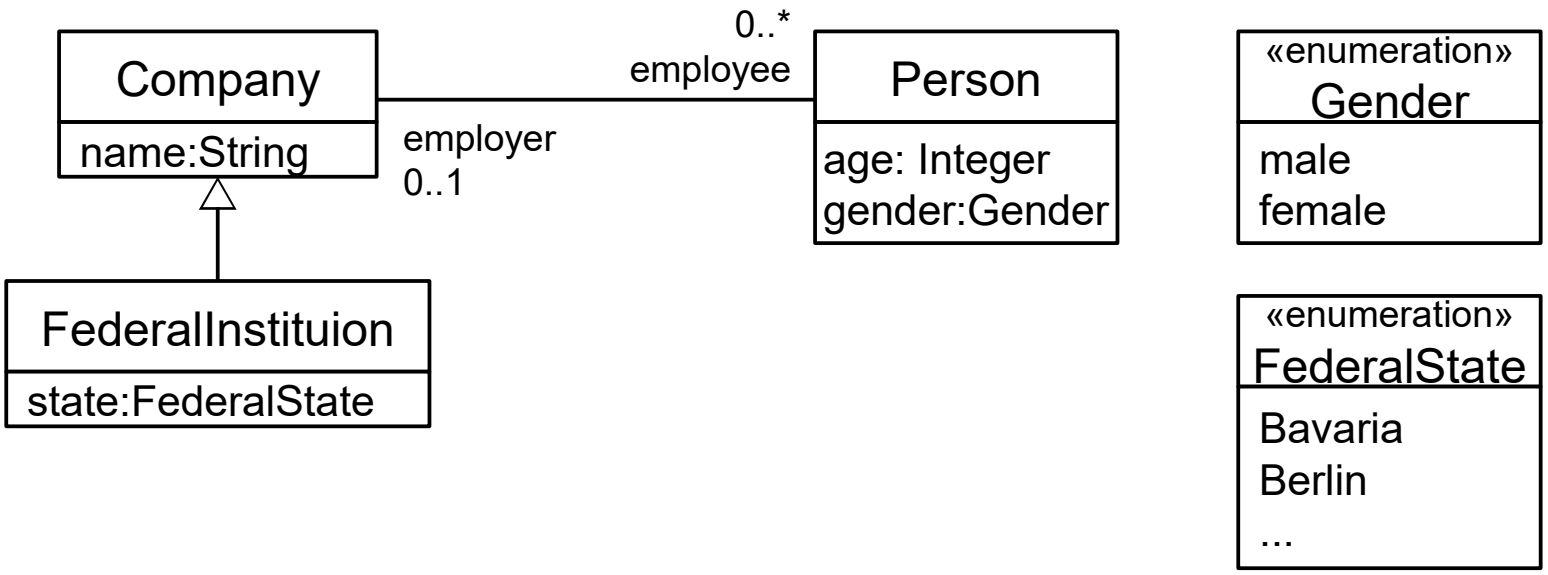

```
context Person
inv:   self.age > 18
```

Accessing Objects and Properties



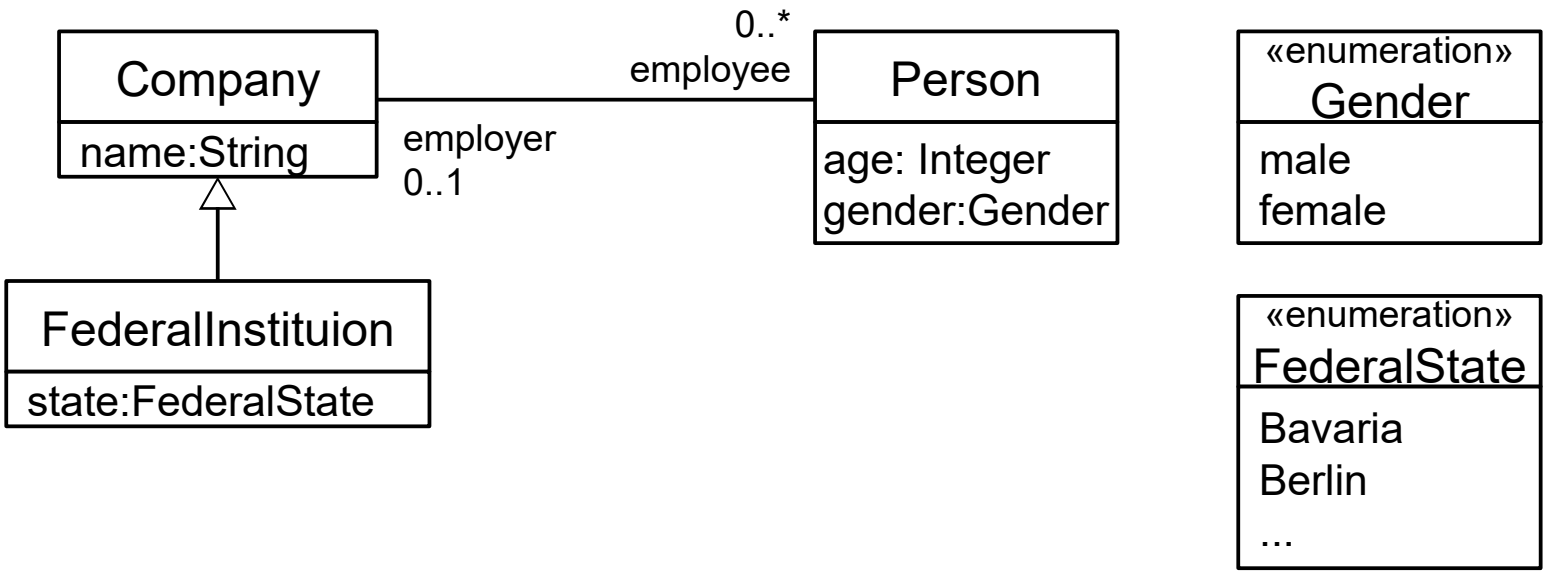

```
context Person
inv:   self.age > 18
inv:   self.gender <> Gender::male
```

Accessing Objects and Properties




```
context Person
inv:   self.age > 18
inv:   self.gender <> Gender::male
inv:   self.employer.oclAsType(FederalInstitution).state =
       FederalState::LowerSaxony
```

Accessing Objects and Properties




```
context Person
inv:   self.age > 18
inv:   self.gender <> Gender::male
inv:   self.employer.oclAsType(FederalInstitution).state =
       FederalState::LowerSaxony
```

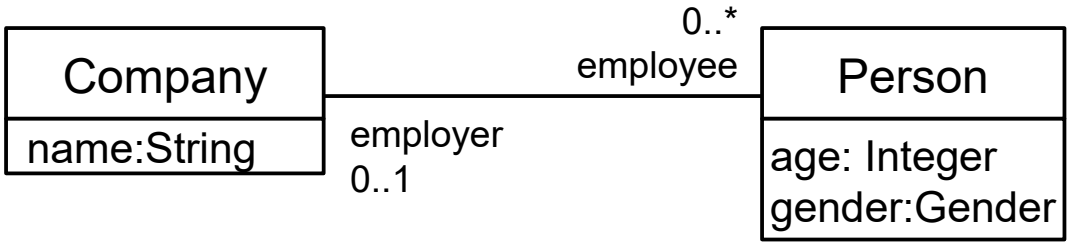
cast

Collection Operations: Select and Reject

- **select** and **reject** are operations on collections to specify subsets
  - **select**: filters elements conforming to a condition
  - **reject**: excludes elements conforming to a condition
  - result type: same as original

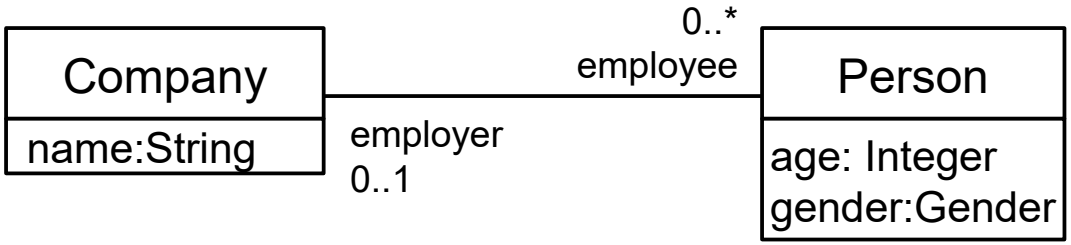
Collection Operations: Select and Reject

- **select** and **reject** are operations on collections to specify subsets
  - **select**: filters elements conforming to a condition
  - **reject**: excludes elements conforming to a condition
  - result type: same as original



Collection Operations: Select and Reject

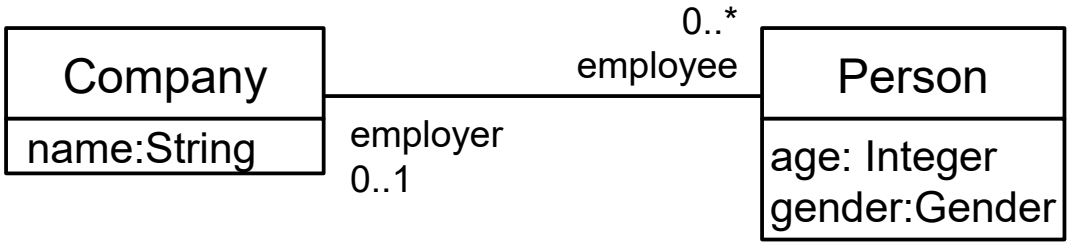
- **select** and **reject** are operations on collections to specify subsets
  - **select**: filters elements conforming to a condition
  - **reject**: excludes elements conforming to a condition
  - result type: same as original




```
context Company
```

Collection Operations: Select and Reject

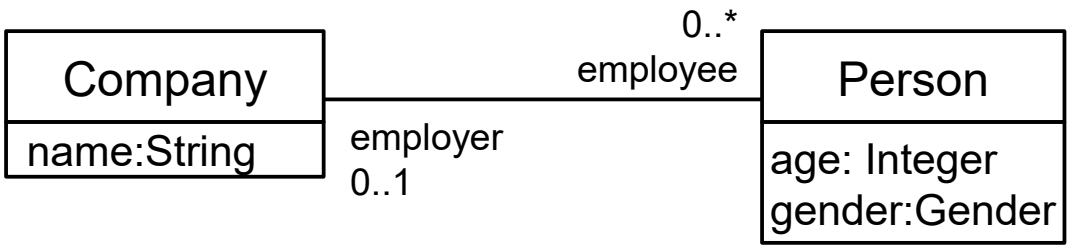
- **select** and **reject** are operations on collections to specify subsets
  - **select**: filters elements conforming to a condition
  - **reject**: excludes elements conforming to a condition
  - result type: same as original




```
context Company
inv:  self.employee->select( age > 65 )->isEmpty()
```

Collection Operations: Collect

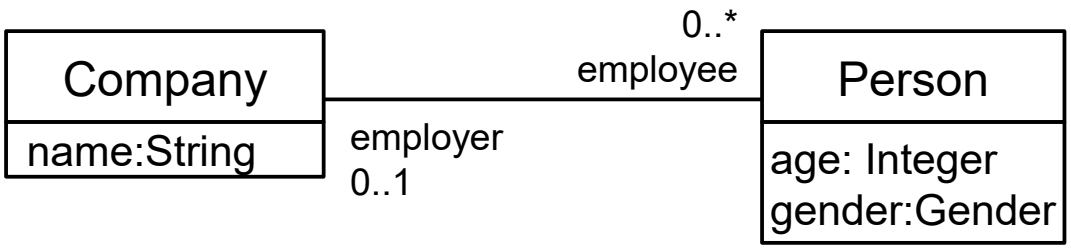
- **collect** operations specify a collection derived from some other collection
  - result type: Bag



returns a bag of integers, for example [32, 55, 43, 32, 27]

Collection Operations: Collect

- **collect** operations specify a collection derived from some other collection
  - result type: Bag

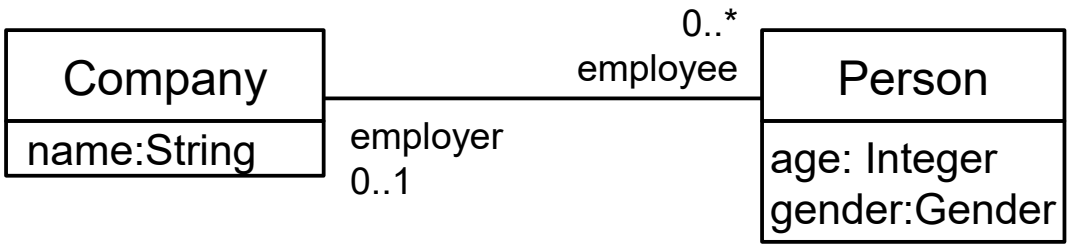



```
context Company
```

returns a bag of integers, for example [32, 55, 43, 32, 27]

Collection Operations: Collect

- **collect** operations specify a collection derived from some other collection
  - result type: Bag

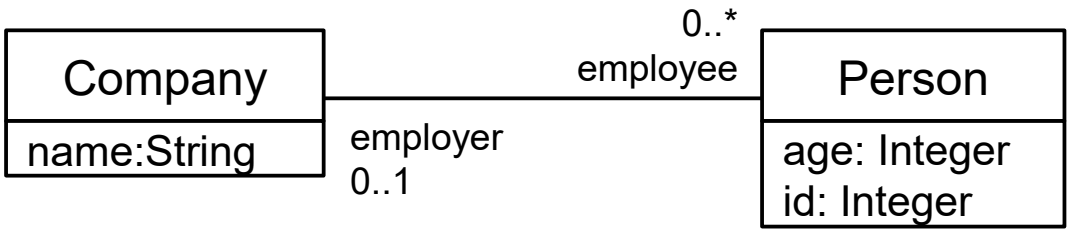



```
context Company
self.employee->collect(age)
```

returns a bag of integers, for example [32, 55, 43, 32, 27]

Collection Operations: ForAll

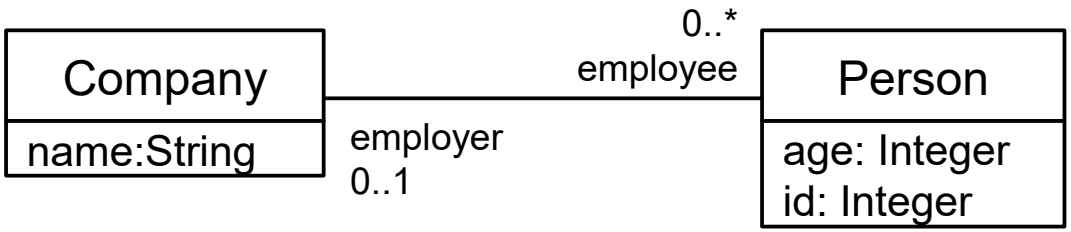
- A **forAll** operation specifies a condition that must hold for all objects in a collection
  - result type: Boolean




```
context Company
inv:   self.employee->forAll( age <= 65 )
```

Collection Operations: ForAll

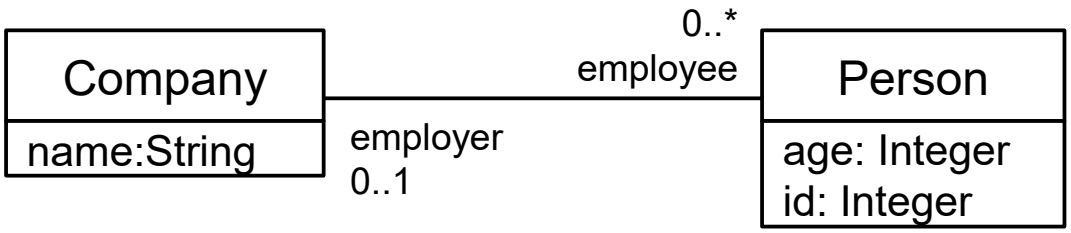
- A **forAll** operation specifies a condition that must hold for all objects in a collection
  - result type: Boolean




```
context Company
inv:   self.employee->forAll( age <= 65 )
inv:   self.employee->forAll( p | p.age <= 65 )
```

Collection Operations: ForAll

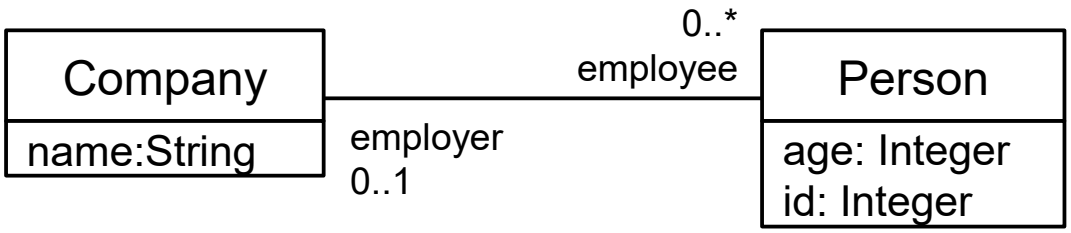
- A **forAll** operation specifies a condition that must hold for all objects in a collection
  - result type: Boolean




```
context Company
inv:   self.employee->forAll( age <= 65 )
inv:   self.employee->forAll( p | p.age <= 65 )
inv:   self.employee->forAll( p : Person | p.age <= 65 )
```

Collection Operations: ForAll

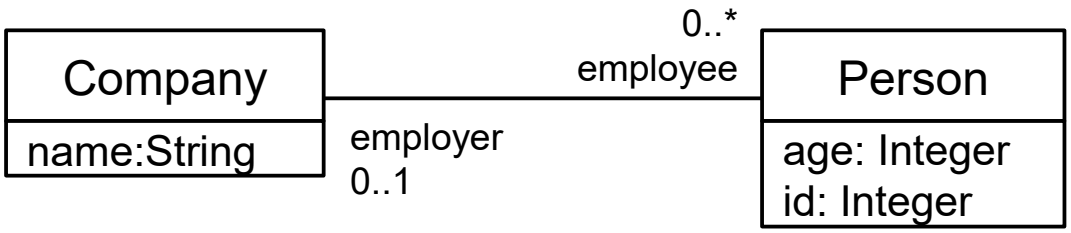
- A **forAll** operation specifies a condition that must hold for all objects in a collection
  - result type: Boolean




```
context Company
inv:   self.employee->forAll( age <= 65 )
inv:   self.employee->forAll( p | p.age <= 65 )
inv:   self.employee->forAll( p : Person | p.age <= 65 )
inv:   self.employee->forAll( p1 |
             self.employee->forAll( p2 |
                  p1 <> p2 implies p1.id <> p2.id ))
```

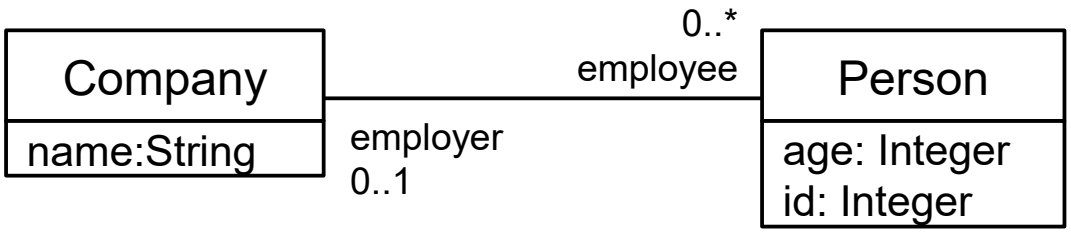
Collection Operations: Exists

- An **exists** operation specifies a condition that must hold for at least one object in a collection
  - result type: Boolean



Collection Operations: Exists

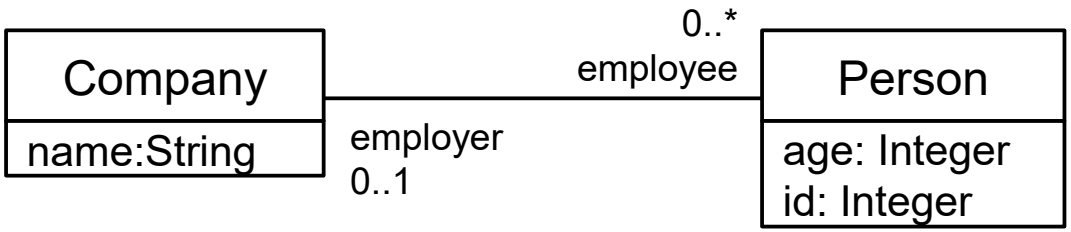
- An **exists** operation specifies a condition that must hold for at least one object in a collection
  - result type: Boolean




```
context Company
```

Collection Operations: Exists

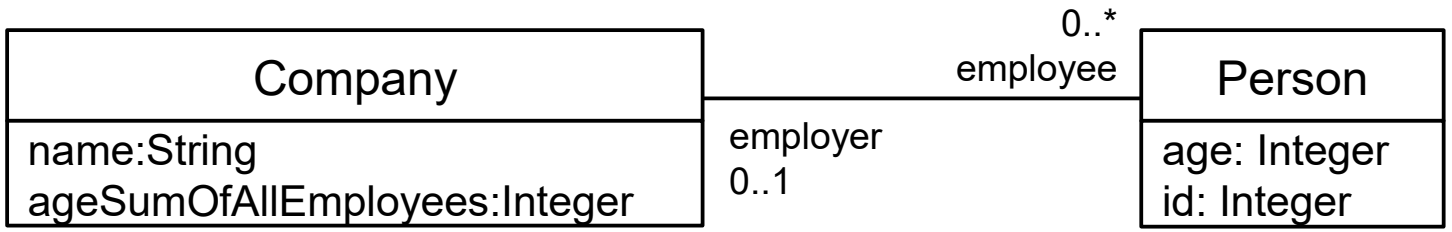
- An **exists** operation specifies a condition that must hold for at least one object in a collection
  - result type: Boolean




```
context Company
inv:   self.employee->exists( age <= 65 )
```

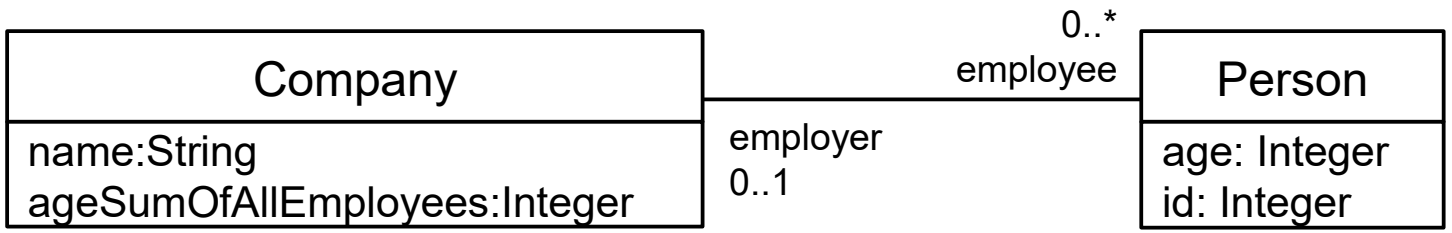
Collection Operations: Iterate

- An **iterate** operation iterates over objects in a collection and accumulates a value of in a certain return type



Collection Operations: Iterate

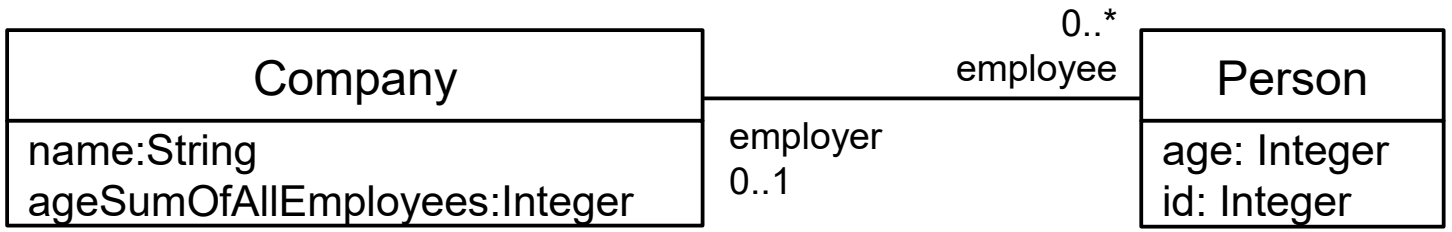
- An **iterate** operation iterates over objects in a collection and accumulates a value of in a certain return type




```
context Company.ageSumOfAllEmployees:Integer
```

Collection Operations: Iterate

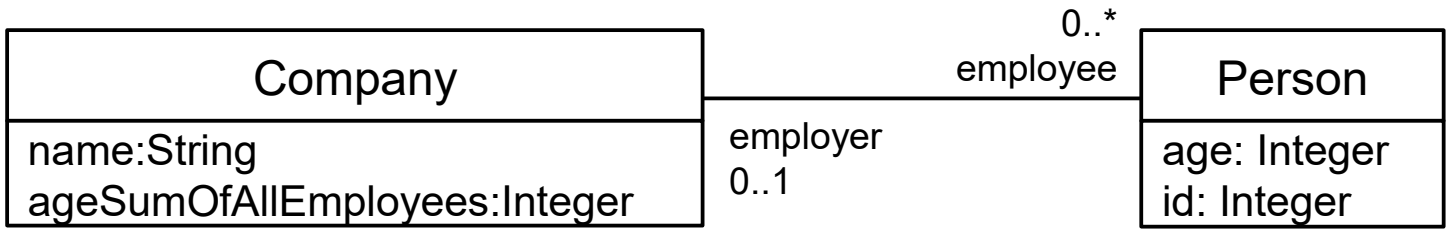
- An **iterate** operation iterates over objects in a collection and accumulates a value of in a certain return type




```
context Company.ageSumOfAllEmployees:Integer
body:  self.employee->iterate(   p:Person ;
```

Collection Operations: Iterate

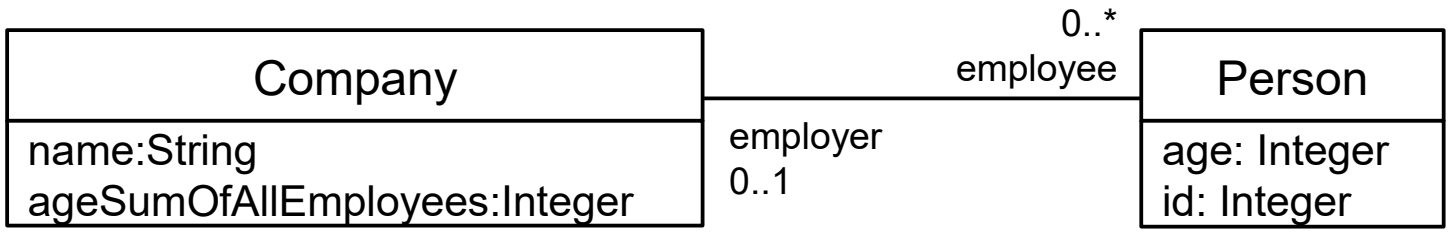
- An **iterate** operation iterates over objects in a collection and accumulates a value of in a certain return type




```
context Company.ageSumOfAllEmployees:Integer
body:  self.employee->iterate(   p:Person ;
                                 sum:Integer = 0 |
```

Collection Operations: Iterate

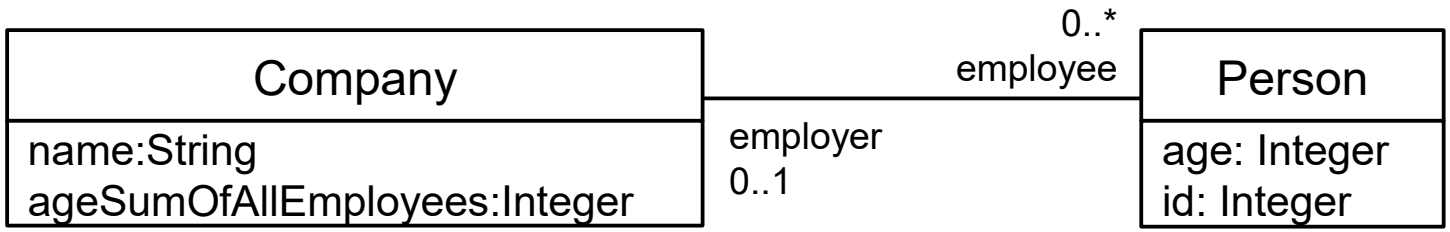
- An **iterate** operation iterates over objects in a collection and accumulates a value of in a certain return type




```
context Company.ageSumOfAllEmployees:Integer
body:  self.employee->iterate(   p:Person ;
                                 sum:Integer = 0 |
                                        sum + p.age)
```

Collection Operations: Iterate

- An **iterate** operation iterates over objects in a collection and accumulates a value of in a certain return type




```
context Company.ageSumOfAllEmployees:Integer
body:  self.employee->iterate(   p:Person ;
                                 sum:Integer = 0 |
                                       sum + p.age)
```

defines the value of the derived attribute

Further OCL Operations

- **`self.oclIsTypeOf`**`(t:OclType):Boolean`
  - returns true if the type of self and t are the same

Further OCL Operations

- **`self.oclIsTypeOf`**`(t:OclType):Boolean`
  - returns true if the type of self and t are the same
- **`self.oclIsKindOf`**`(t:OclType):Boolean`
  - returns true if the type of self and t are the same or if t is a supertype of the type of self.

Further OCL Operations

- **`self.oclIsTypeOf`**`(t:OclType):Boolean`
  - returns true if the type of self and t are the same
- **`self.oclIsKindOf`**`(t:OclType):Boolean`
  - returns true if the type of self and t are the same or if t is a supertype of the type of self.
- **`self.oclAsType`**`(t:OclType):T`
  - “cast” operator, returns self as an object of type T.

Further OCL Operations

- **`self.oclIsTypeOf`**`(t:OclType):Boolean`
  - returns true if the type of self and t are the same
- **`self.oclIsKindOf`**`(t:OclType):Boolean`
  - returns true if the type of self and t are the same or if t is a supertype of the type of self.
- **`self.oclAsType`**`(t:OclType):T`
  - “cast” operator, returns self as an object of type T.
- **`allInstances()`**
  - Operation on classes, interfaces, or enumerations
  - returns all instances of the type

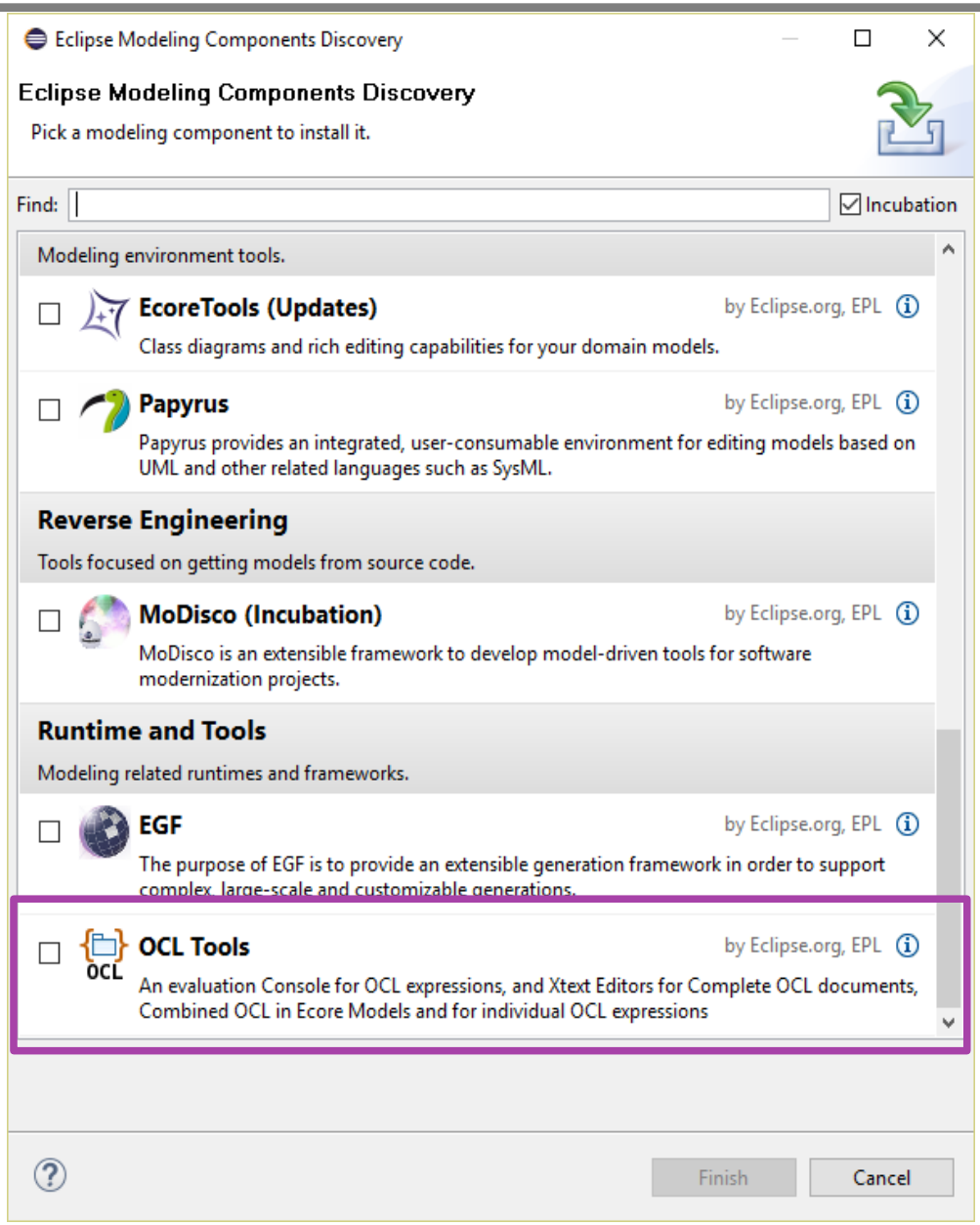
SOFTWARE ENGINEERING

3.3. OCL in Ecore

Leibniz Universität Hannover

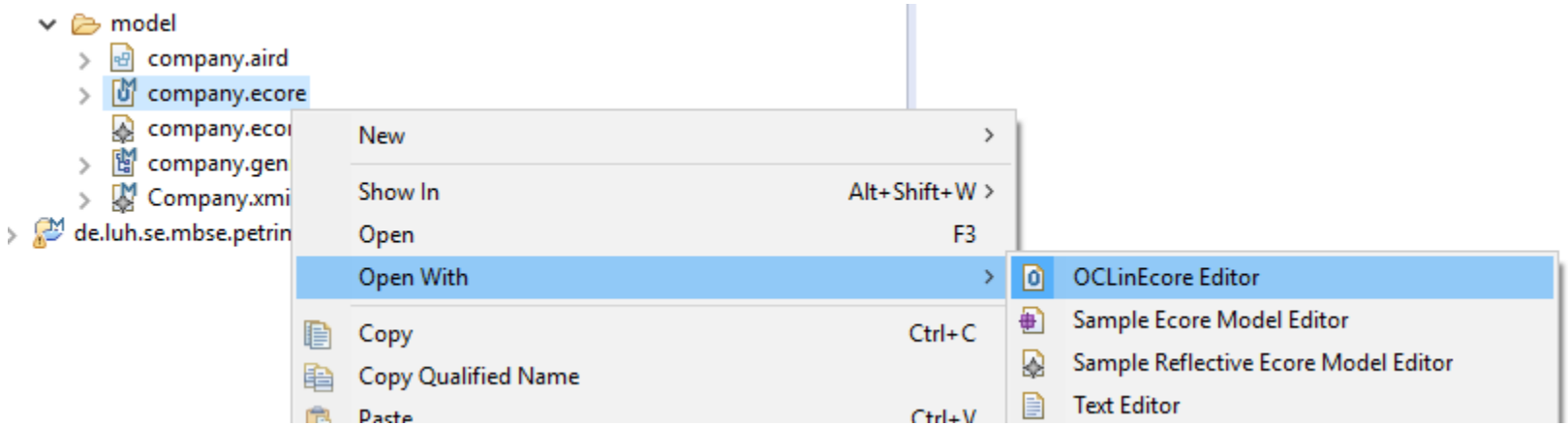
Eclipse OCL Tools

- Installation:



OCLinEcore Editor

- You can open .ecore files with the OCLinEcore editor



OCLinEcore Editor
Example: Company

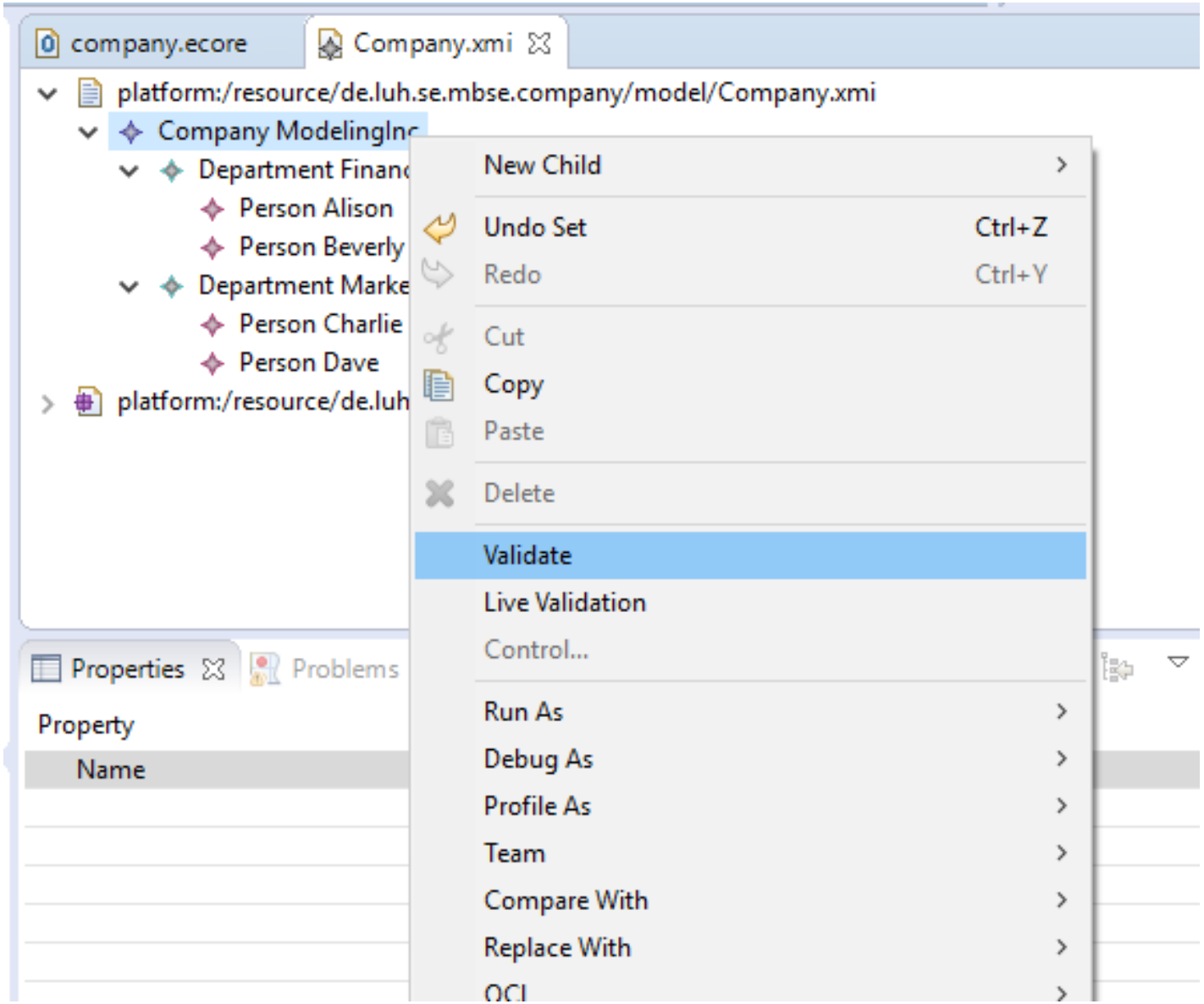
company.ecore

```
1  import ecore : 'http://www.eclipse.org/emf/2002/Ecore' ;
2
3  package company : company = 'http://www.example.org/company'
4  {
5      class Company extends NamedElement
6      {
7          property department : Department[*] { ordered composes };
8      }
9      class Department extends NamedElement
10     {
11         property employee : Person[*] { ordered composes };
12         attribute ageSumOfEmployees : ecore::EInt[?] { derived readonly transient volatile }
13         {
14             initial: self.employee->iterate(p; sum:Integer = 0 | sum + p.age);
15         }
16     }
17     class NamedElement
18     {
19         attribute name : String[?];
20     }
21     class Person extends NamedElement
22     {
23         attribute age : ecore::EInt[?];
24         invariant AllEmployeesMustBeAdults: self.age >= 18;
25     }
26 }
```

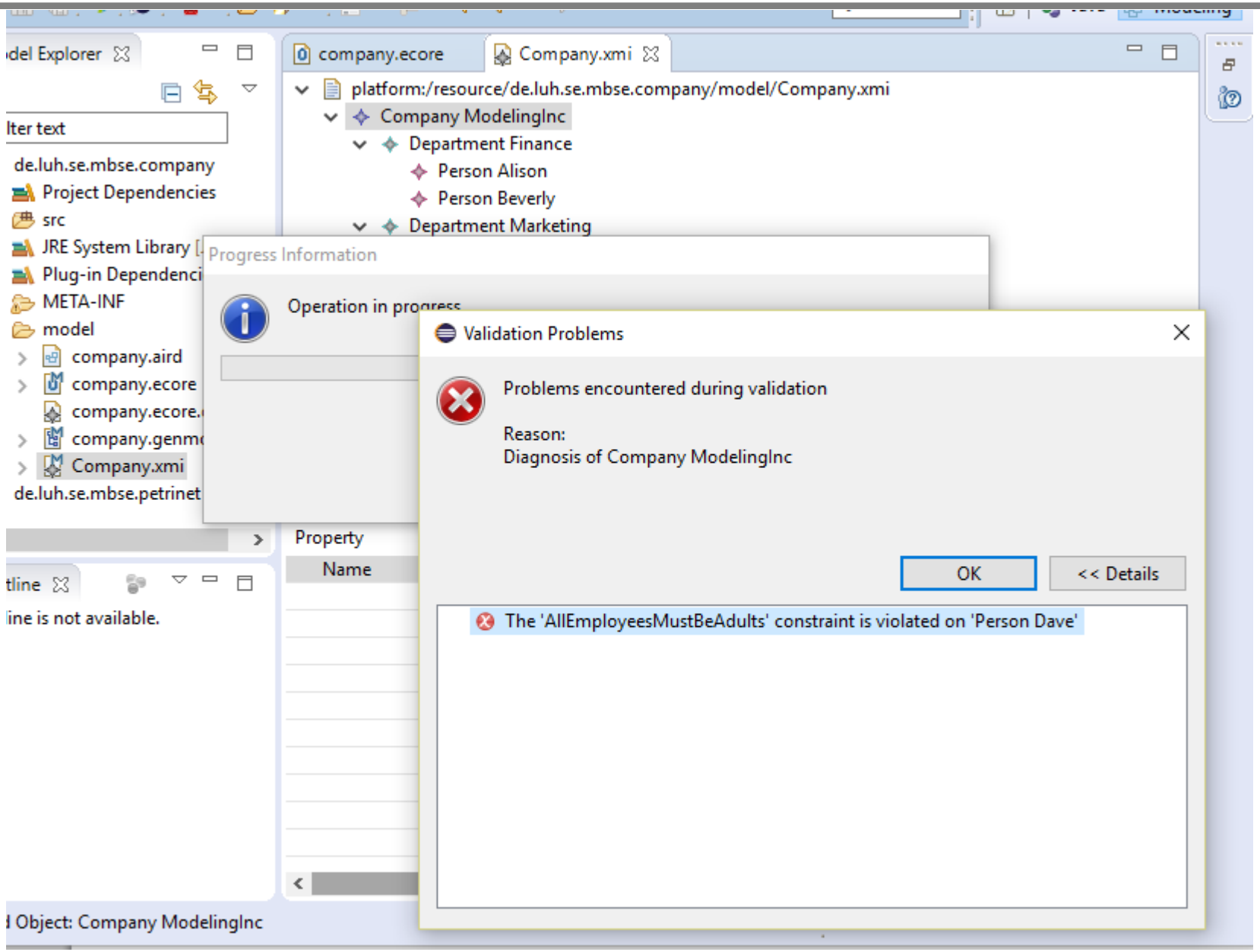
derived attribute

invariant

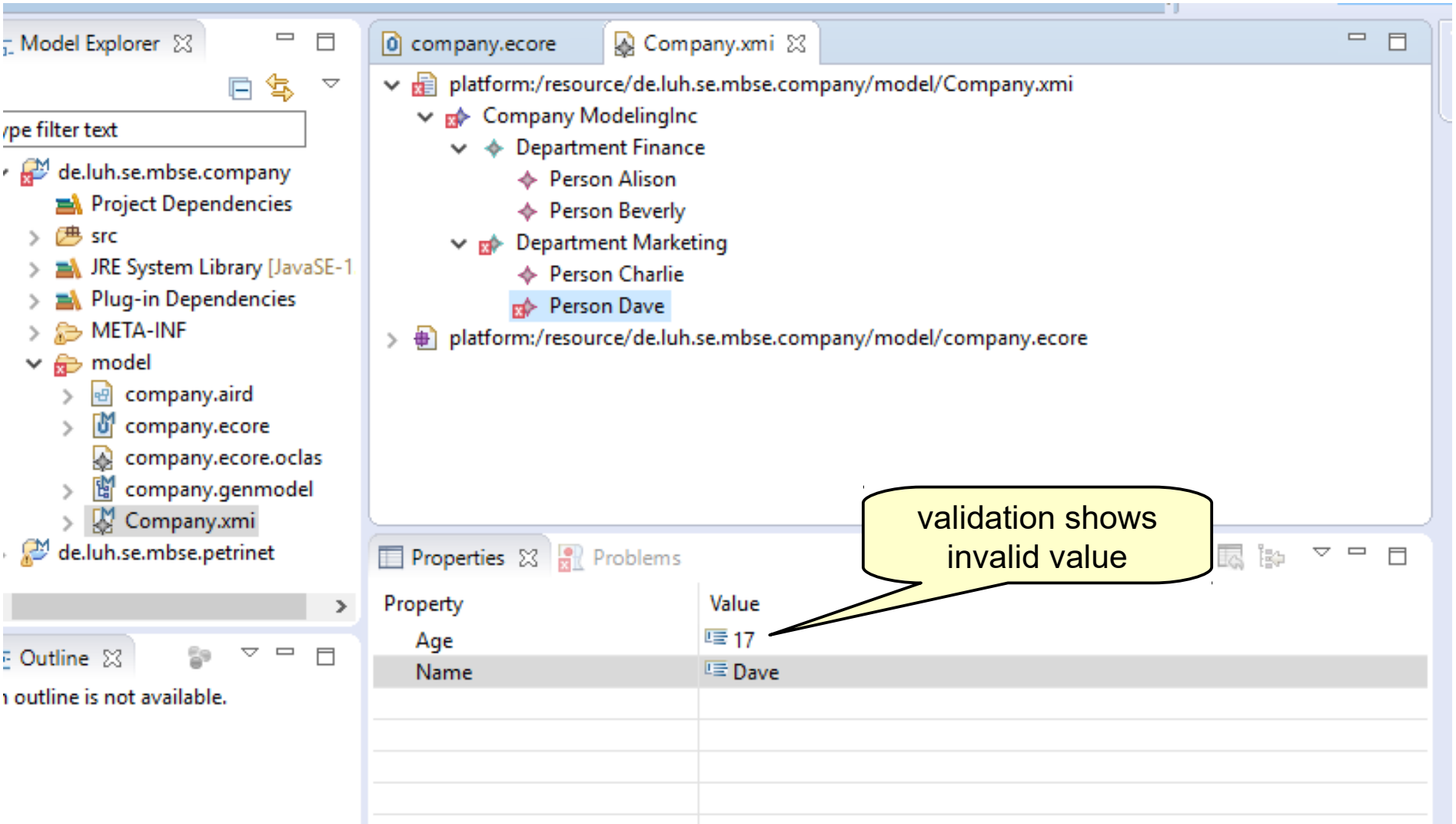
OCLinEcore Editor Example: Company



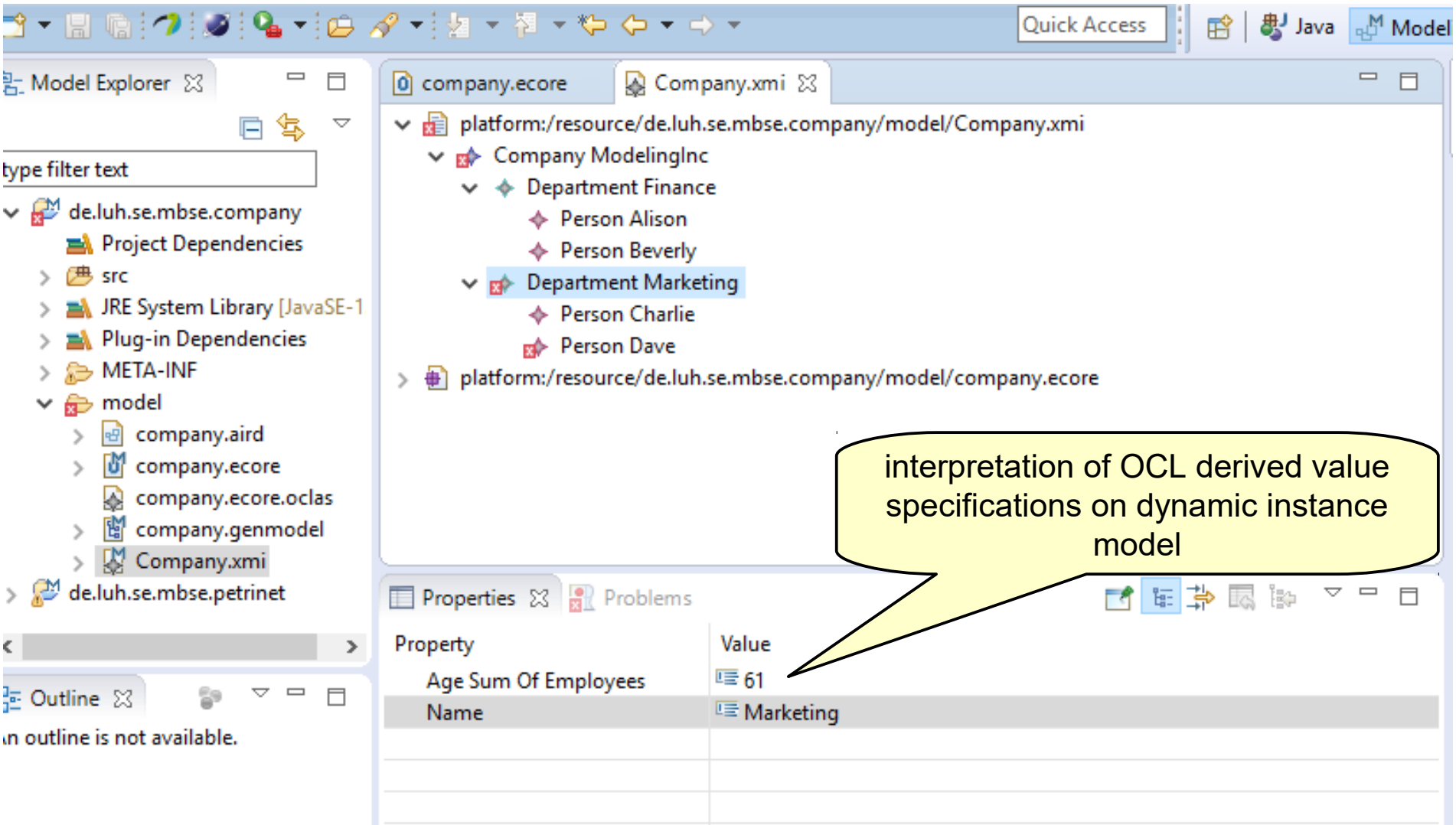
OCLinEcore Editor Example: Company



OCLinEcore Editor Example: Company



OCLinEcore Editor Example: Company



OCLinEcore Editor Example: Petri net

petrinet.ecore

```
1  import ecore : 'http://www.eclipse.org/emf/2002/Ecore' ;
2
3  package petrinet : petrinet = 'http://www.example.org/petrinet'
4  {
5      class PetriNet
6      {
7          property element : Element[*] { ordered composes };
8      }
9      abstract class Element;
10     abstract class Node extends Element
11     {
12         attribute name : String[?];
13     }
14     class Place extends Node
15     {
16         attribute initialMarkings : ecore::EInt[?];
17     }
18     class Transition extends Node;
19     class Arc extends Element
20     {
21         property source : Node[1];
22         property target : Node[1];
23         invariant NoArcsBetweenNodesOfTheSameKind:
24             ((self.source.oclIsKindOf(Place) and
25                 self.target.oclIsKindOf(Transition))
26             or
27             (self.source.oclIsKindOf(Transition) and
28                 self.target.oclIsKindOf(Place) ) );
29     }
30 }
```

Summary OCL

- Formal, textual language for specifying queries and constraints on models with a MOF/UML metamodel
- Typed language
- No “programming”, no side-effects
- Tool support for EMF
- Used in other languages
  - we will see it again!