Model Management
in Xtend
(first part)

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Material

http://mathieuacher.com/teaching/MDE/

Plan

- Model Management in a nutshell
  - Loading, serializing, transforming models
- Xtend
  - Java 10, cheatsheet
  - Advanced features: extension methods, active annotations, template expressions
  - Xtend: behing the magic (Xtext+MDE)
- Model Management + Xtend
  - Model transformations
  - @Aspect annotation
  - Xtend + Xtext (breathing life into DSLs)

Contract

- Practical foundations of model management
- Learning and understanding Java 10 (aka Xtend)
  - advanced features of a general GPL, implementation of a sophisticated language using MDE
- Model transformations
  - Model-to-Text
  - Model-to-Model
- Metaprogramming
  - Revisit annotations (e.g., as in JPA or many frameworks)
- DSLs and model management: all together (Xtext + Xtend)

Model Management

Scenarios

Motivating Scenario

```
PollSystem {
    Poll Quality {
        Question q1 {
            "Value the user experience"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
        Question q2 {
            "Value the layout"
            options {
                A : "It was not easy to locate elements"
                B : "I didn't realize"
                C : "It was easy to locate elements"
            }
        }
    }
    Poll Performance {
        Question q1 {
            "Value the time response"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
    }
}
```

Challenge 1:

web forms so that admins can specify and edit « polls »

```
PollSystem {
    Poll Quality {
        Question q1 {
            "Value the user experience"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
        Question q2 {
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                A : "It was not easy to locate elements"
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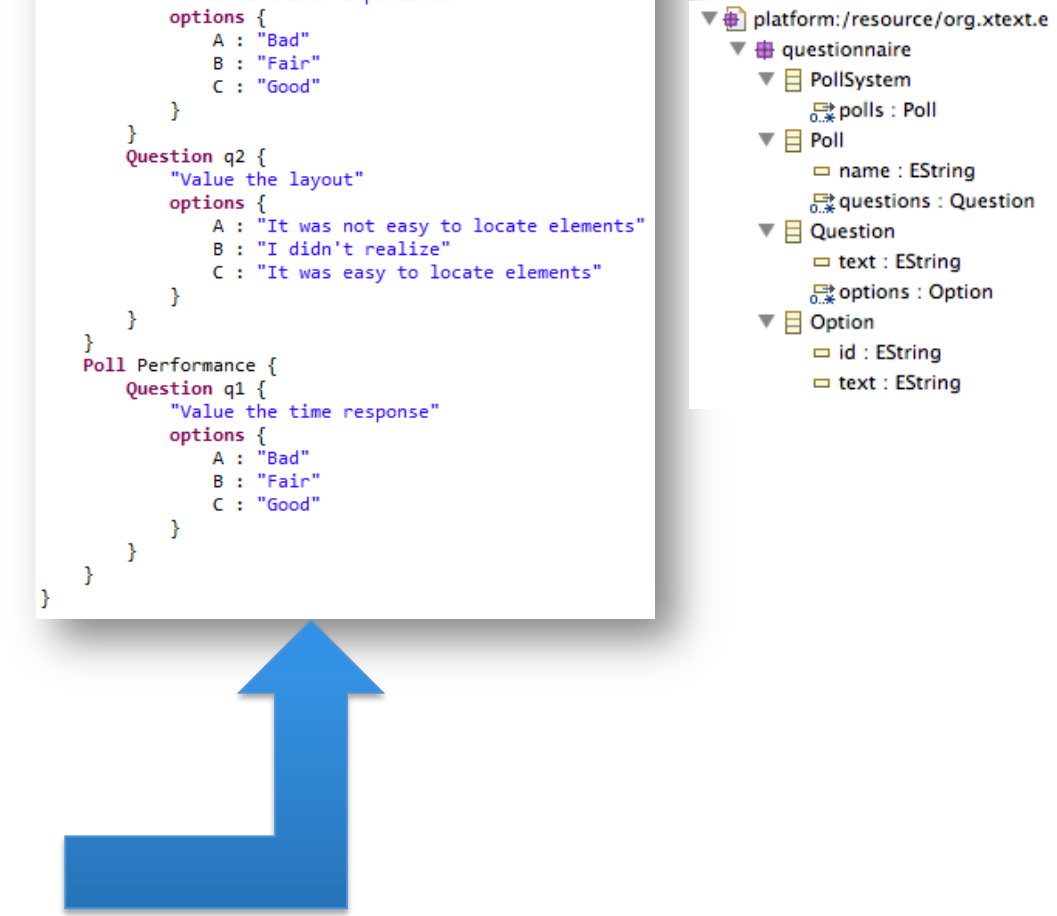
        }
    }
    Poll Performance {
        Question q1 {
            "Value the time response"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
    }
}
```



JSON ?

Interoperability with the Xtext MM ?

Challenge 2:

enable the customization of « widgets » (checkbox, images)

```
PollSystem {
    Poll Quality {
        Question q1 {
            "Value the user experience"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
        Question q2 {
            "Value the layout"
            options {
                A : "It was not easy to locate elemer
                B : "I didn't realize"
                C : "It was easy to locate elements"
            }
        }
    }
    Poll Performance {
        Question q1 {
            "Value the time response"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
    }
}
```

poll1

What is A ?

- B
- C
- D

poll2

What is D ?

- E
- F

Challenge 2:

enable the customization of « widgets » (checkbox, images)

```
PollSystem {
    Poll Quality {
        Question q1 {
            "Value the user experience"
            options {
                A : "Bad"
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    }
    Poll Performance {
        Question q1 {
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            options {
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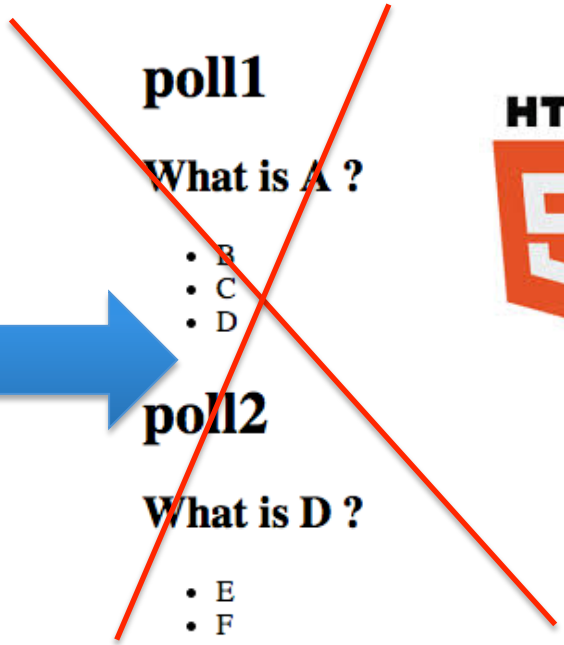
                B : "Fair"
                C : "Good"
            }
        }
    }
}
```



#1 A dedicated DSL for specifying the customization (separated or augment the initial DSL)

Challenge 2:

enable the customization of « widgets » (checkbox, images)

```
PollSystem {
    Poll Quality {
        Question q1 {
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            options {
                A : "Bad"
                B : "Fair"
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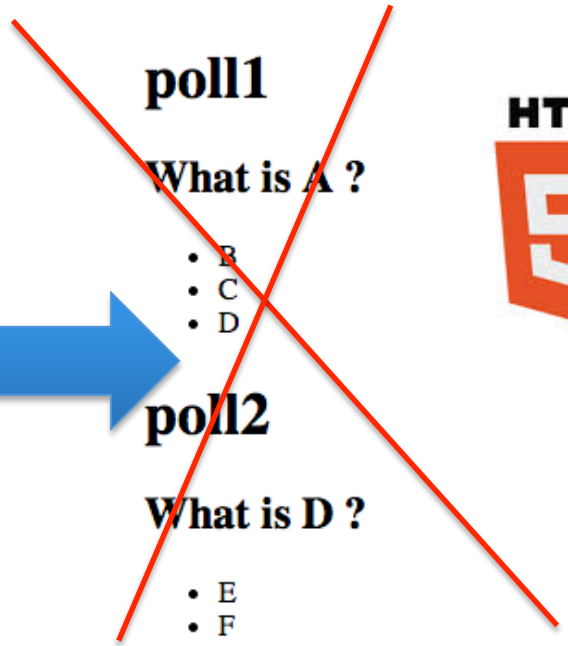
            }
        }
    }
}
```



#2 A « pivot » metamodel for the generators

identify common abstractions

MDE chain


```
PollSystem {
    Poll Quality {
        Question q1 {
            "Value the user experience"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
        Question q2 {
            "Value the layout"
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            }
        }
    }
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        Question q1 {
            "Value the time response"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
    }
}
```

Model-to-Model

Pivot MM

UI model

Text-to-Model

Generator

Model-to-Text

(web forms)

Model Transformations

Taxonomy + Examples

Abstraction Gap

Transformation is the key

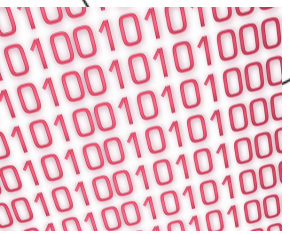
Problem space

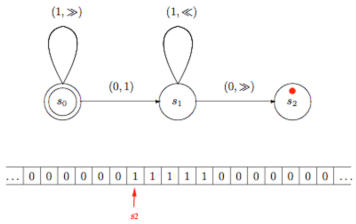
domain–specific language

Transformation

Solution space

implementation language



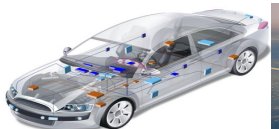


orange™

android

Google

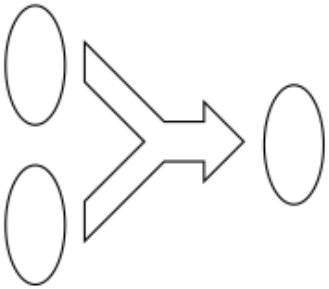
twitter



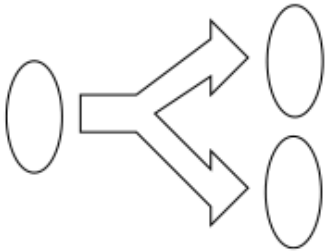
Overview of Generative Software Development

Krzysztof Czarnecki

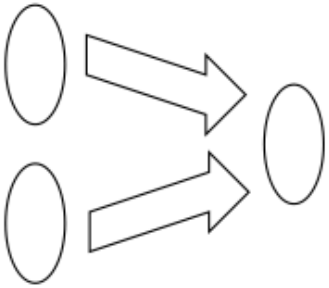
a. Chaining of mappings



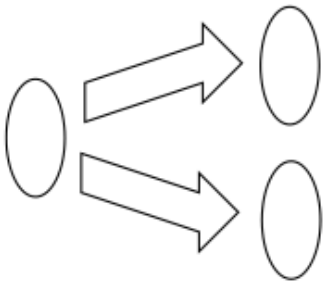
b. Multiple problem spaces



c. Multiple solution spaces



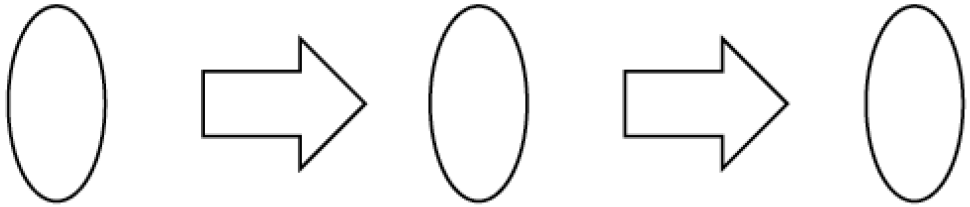
d. Alternative problem spaces



e. Alternative solution spaces

One step/stage transformation

hardly the case



a. Chaining of mappings

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        Question q2 {
            "Value the layout"
            options {
                A : "It was not easy to locate elements"
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                C : "It was easy to locate elements"
            }
        }
    }
    Poll Performance {
        Question q1 {
            "Value the time response"
            options {
                A : "Bad"
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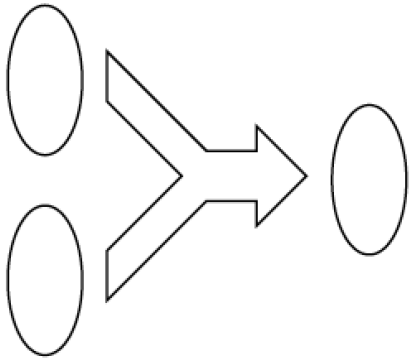
                C : "Good"
            }
        }
    }
}
```

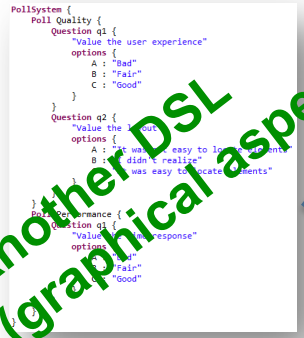
UI model

Problem space

Combination of expertises/aspects/DSLs



b. Multiple problem spaces



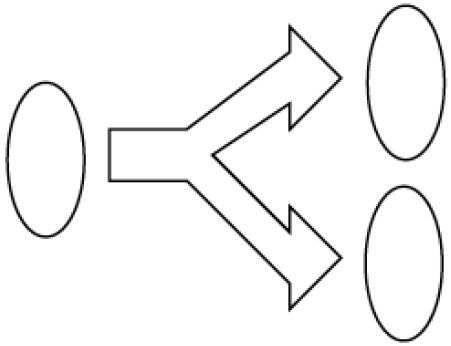
Another DSL (graphical aspect)

(structural/data aspect)

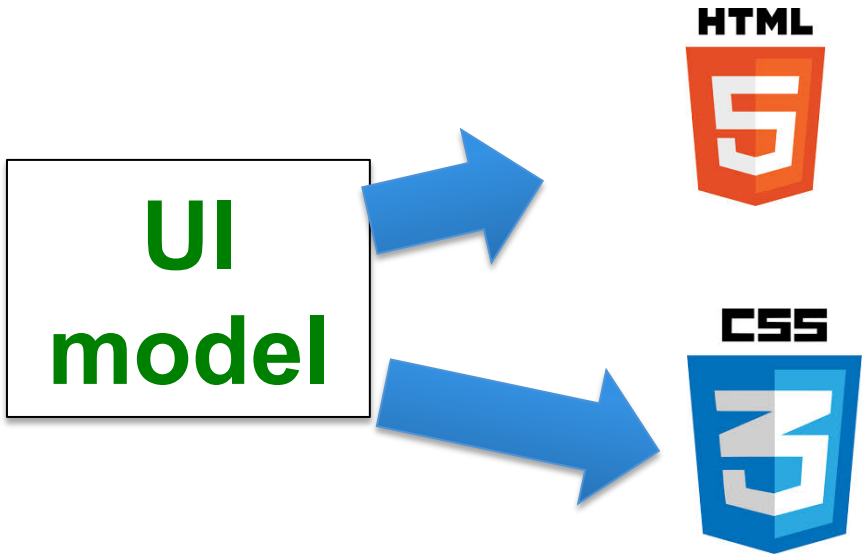
UI model

Solution space

Different targets (e.g., technological platforms)

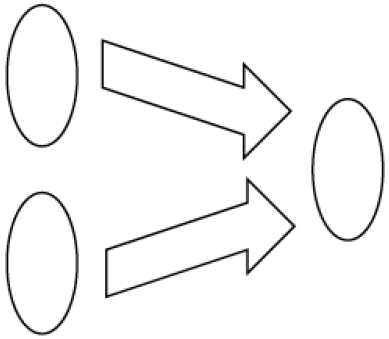


c. Multiple solution spaces



Problem space

e.g., different concrete syntaxes



d. Alternative problem spaces

```
PollSystem {
    Poll Quality {
        Question q1 {
            "Value the user experience"
            options {
                A : "Bad"
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                C : "Good"
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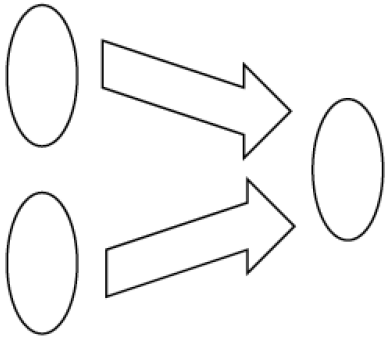
        Question q2 {
            "Value the layout"
            options {
                A : "It was not easy to locate elemen
                B : "I didn't realize"
                C : "It was easy to locate elements"
            }
        }
    }
    Poll Performance {
        Question q1 {
            "Value the time response"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
    }
}
```

UI model

JSON

Problem space

e.g., different concrete syntaxes



d. Alternative problem spaces

```
PollSystem {
    Poll Quality {
        Question q1 {
            "Value the user experience"
            options {
                A : "Bad"
                B : "Fair"
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            }
        }
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            "Value the layout"
            options {
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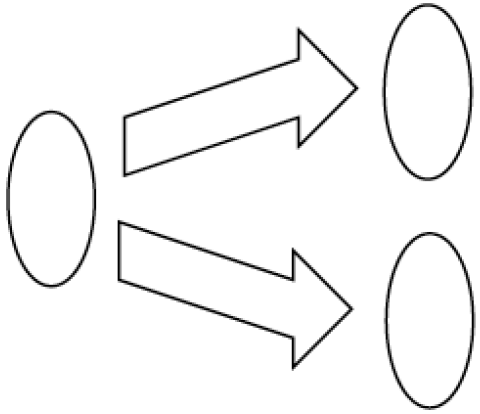
            }
        }
    }
    Poll Performance {
        Question q1 {
            "Value the time response"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
    }
}
```

UI model

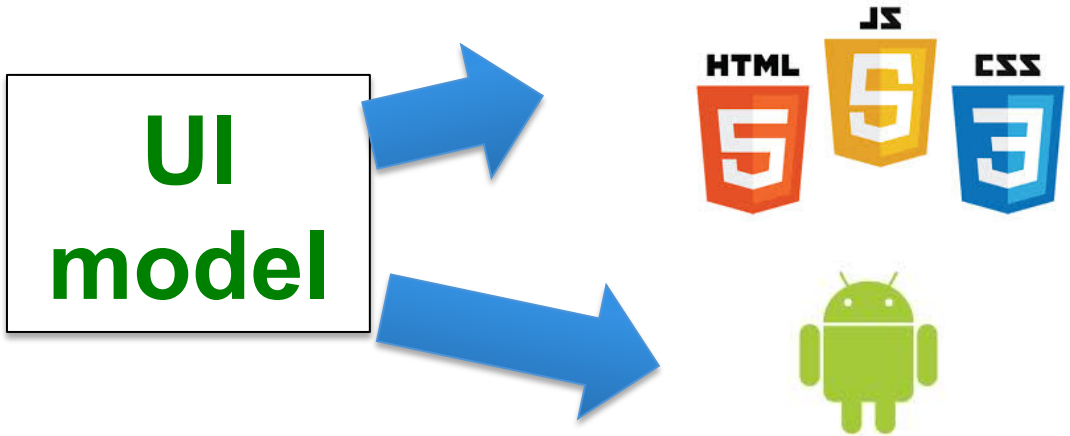
Feature Model
(see next courses and TP6)

Solution space

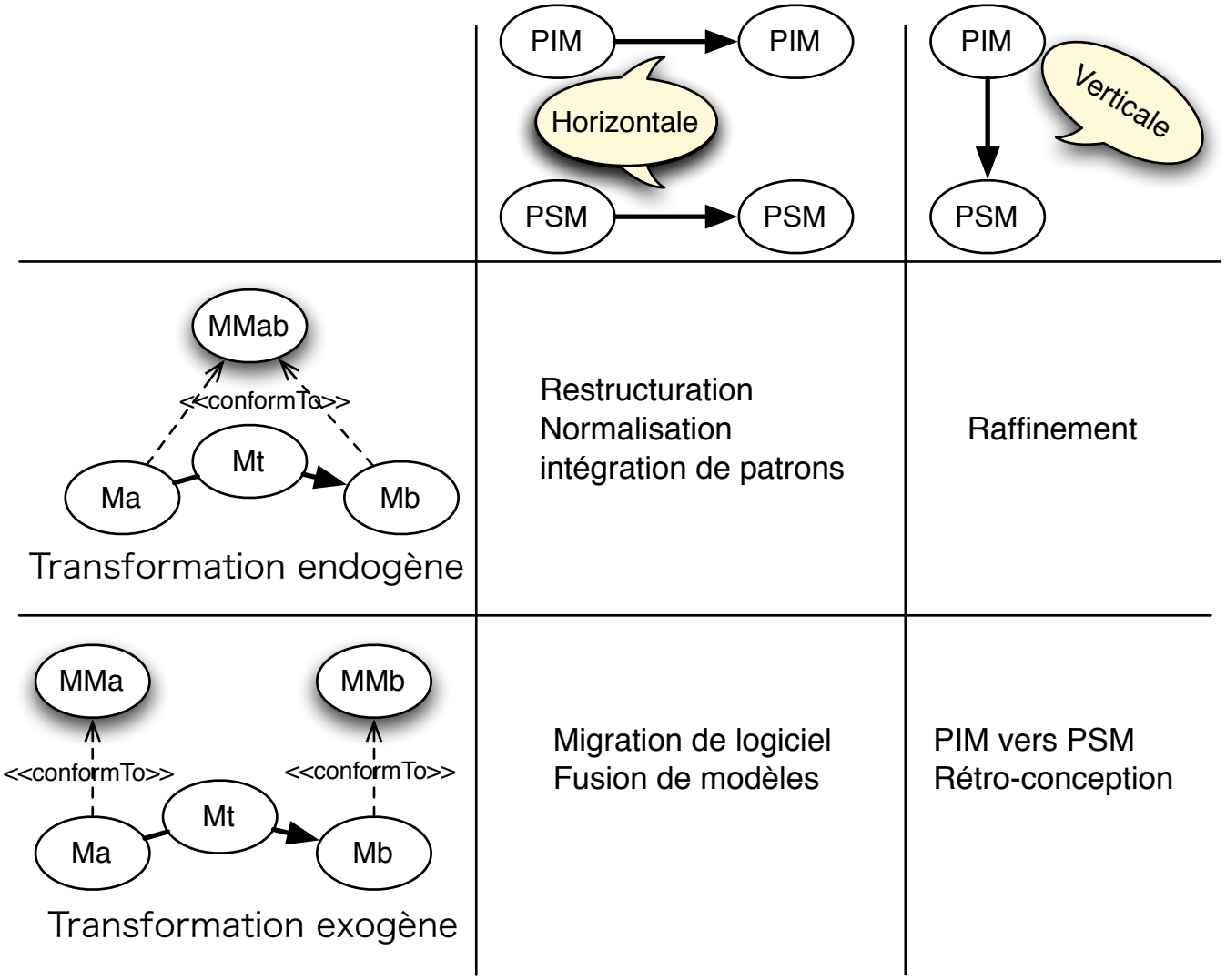
Different targets (e.g., technological platforms)



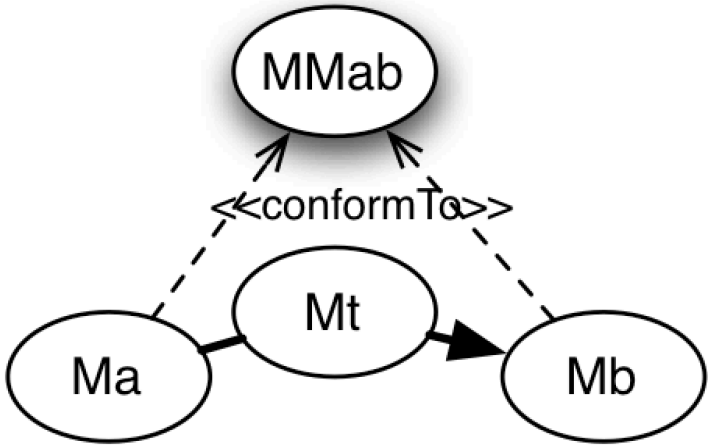
e. Alternative solution spaces



Model Transformation: Taxonomy



Endogeneous Transformation



foo1.q

```
PollSystem {

    Poll poll1 {

        Question A {
            "What is A ?"
            options
                b : "B"
                c : "C"
                d : "D"

        }

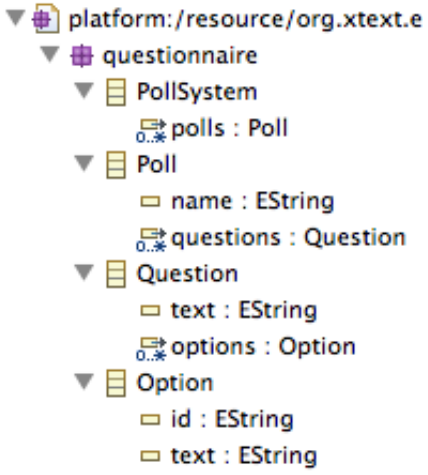
    }

    Poll poll2 {

        Question D {
            "What is D ?"
            options
                e : "E"
                f : "F"

        }

    }
}
```



foo1.q | foo2.q

```
PollSystem {

    Poll poll1_poll {

        Question {
            "What is A ?"
            options
                b : "B"
                c : "C"
                d : "D"

        }

    }

    Poll poll2_poll {

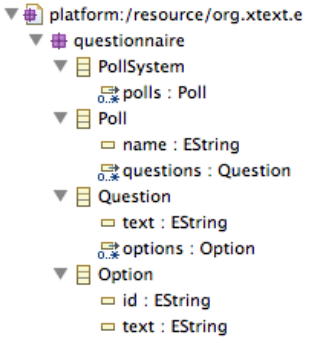
        Question {
            "What is D ?"
            options
                e : "E"
                f : "F"

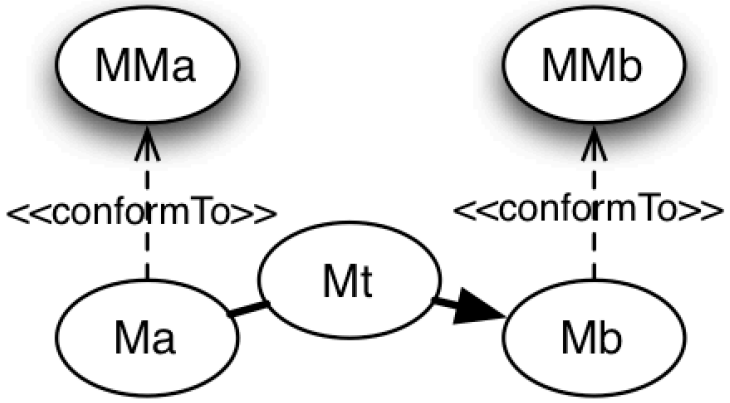
        }

    }
}
```

Exogeneous Transformation

(metamodel)





foo1.q

```
PollSystem {

    Poll poll1 {

        Question A {
            "What is A ?"
            options
                    b : "B"
                    c : "C"
                    d : "D"

        }

    }

    Poll poll2 {

        Question D {
            "What is D ?"
            options
                    e : "E"
                    f : "F"

        }

    }

}
```

poll1

What is A ?

- B
- C
- D

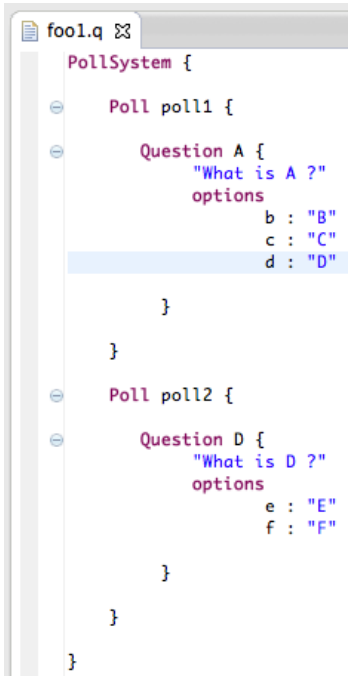
poll2

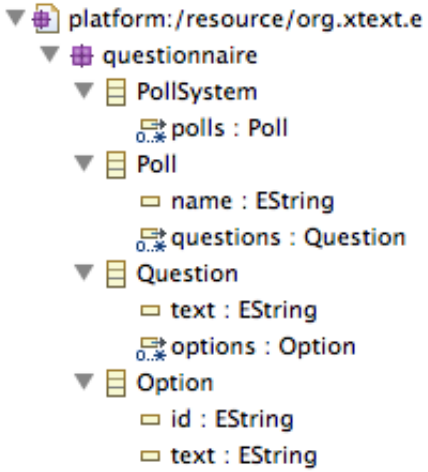
What is D ?

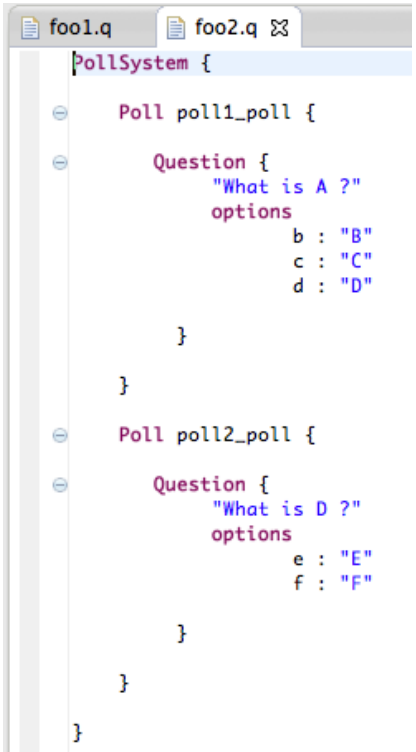
- E
- F

Vertical Transformation

source and target models reside at the same abstraction level (e.g., refactoring)







Horizontal Transformation

the source and target models reside at different abstraction levels (e.g., refinement)

foo1.q

```
PollSystem {

    Poll poll1 {

        Question A {
            "What is A ?"
            options
                b : "B"
                c : "C"
                d : "D"

        }

    }

    Poll poll2 {

        Question D {
            "What is D ?"
            options
                e : "E"
                f : "F"

        }

    }

}
```

poll1

What is A ?

- B
- C
- D

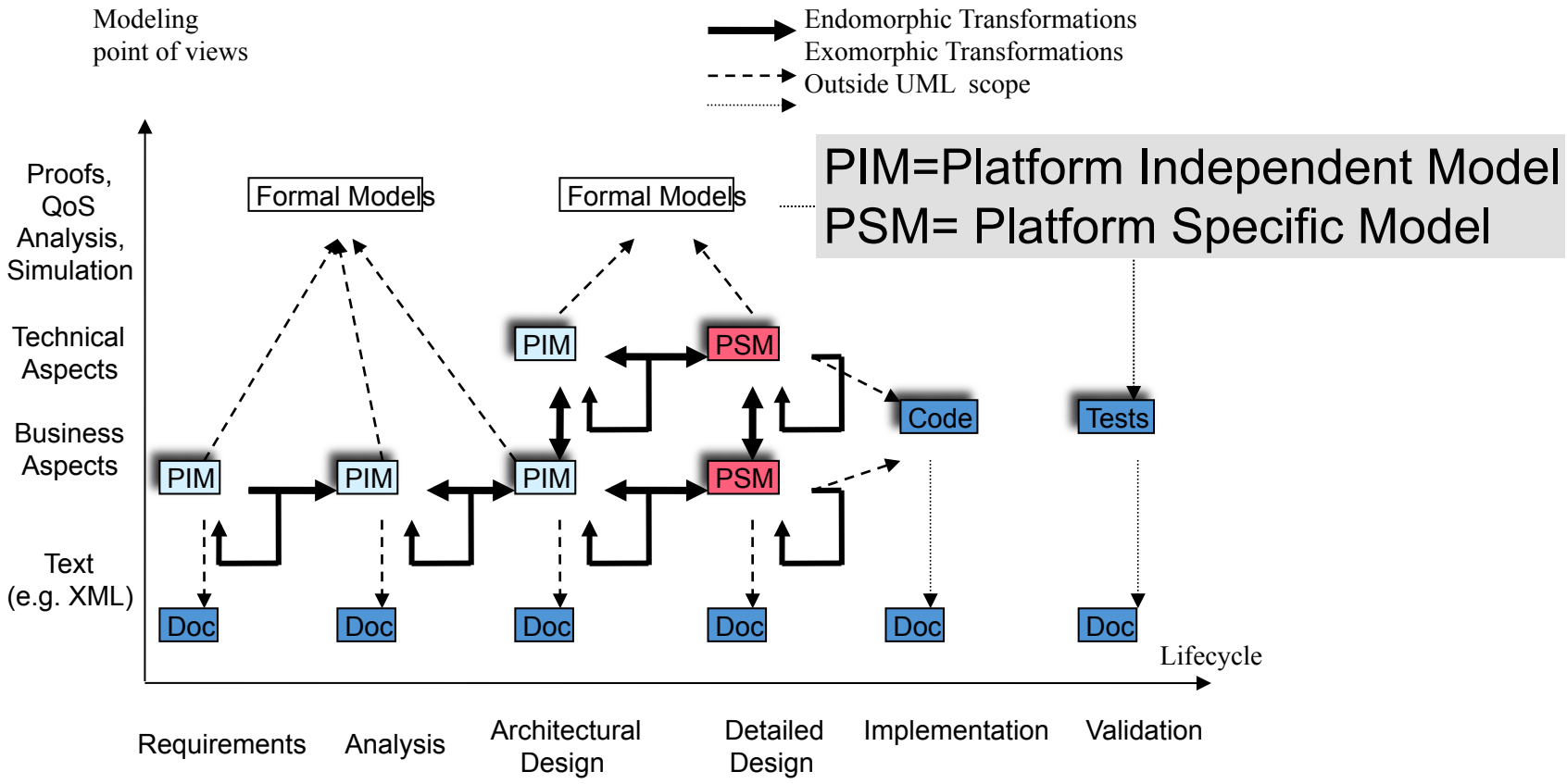
poll2

What is D ?

- E
- F

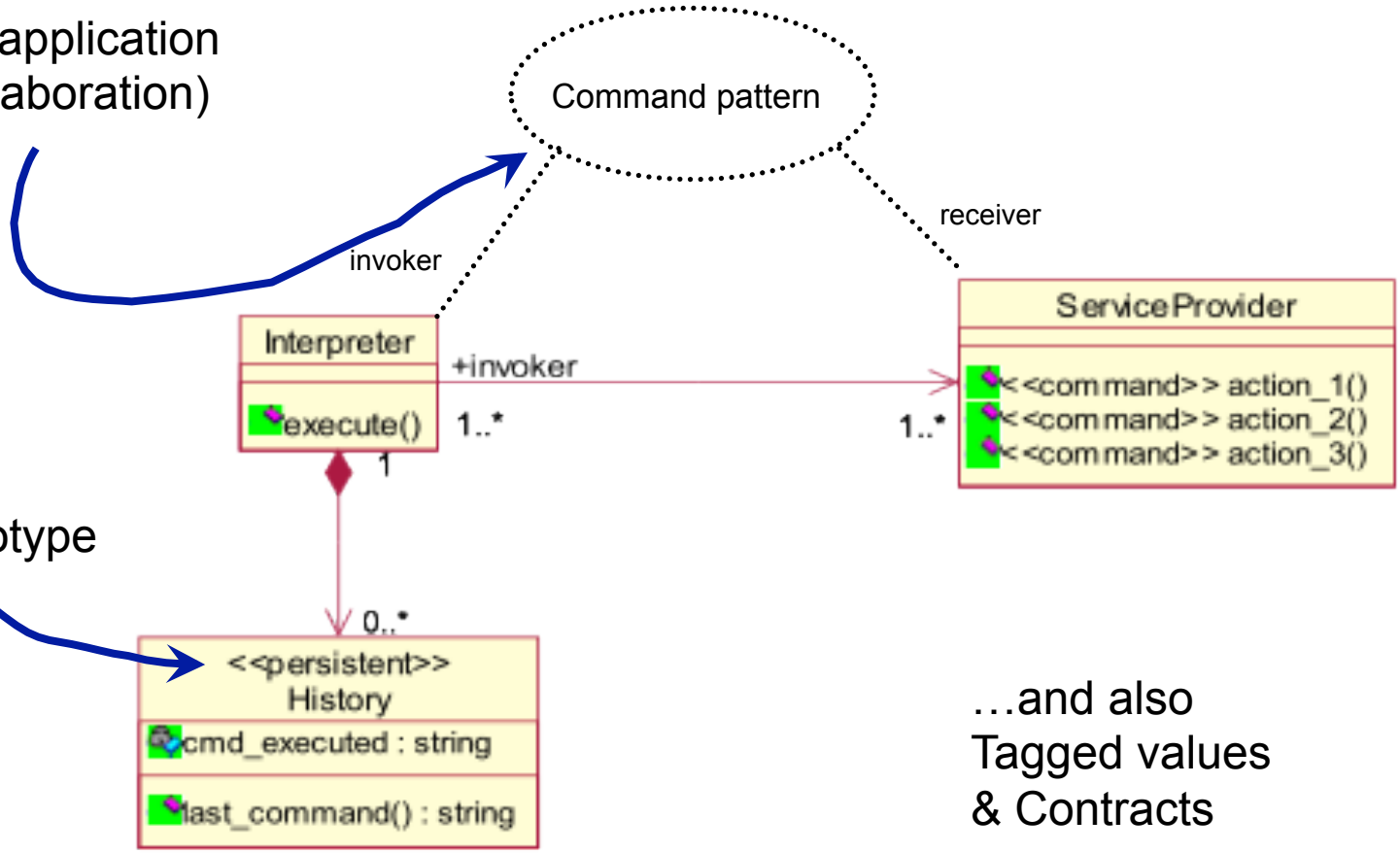
Chaining of Transformations

Back to the first courses



Embedding implicit semantics into a model

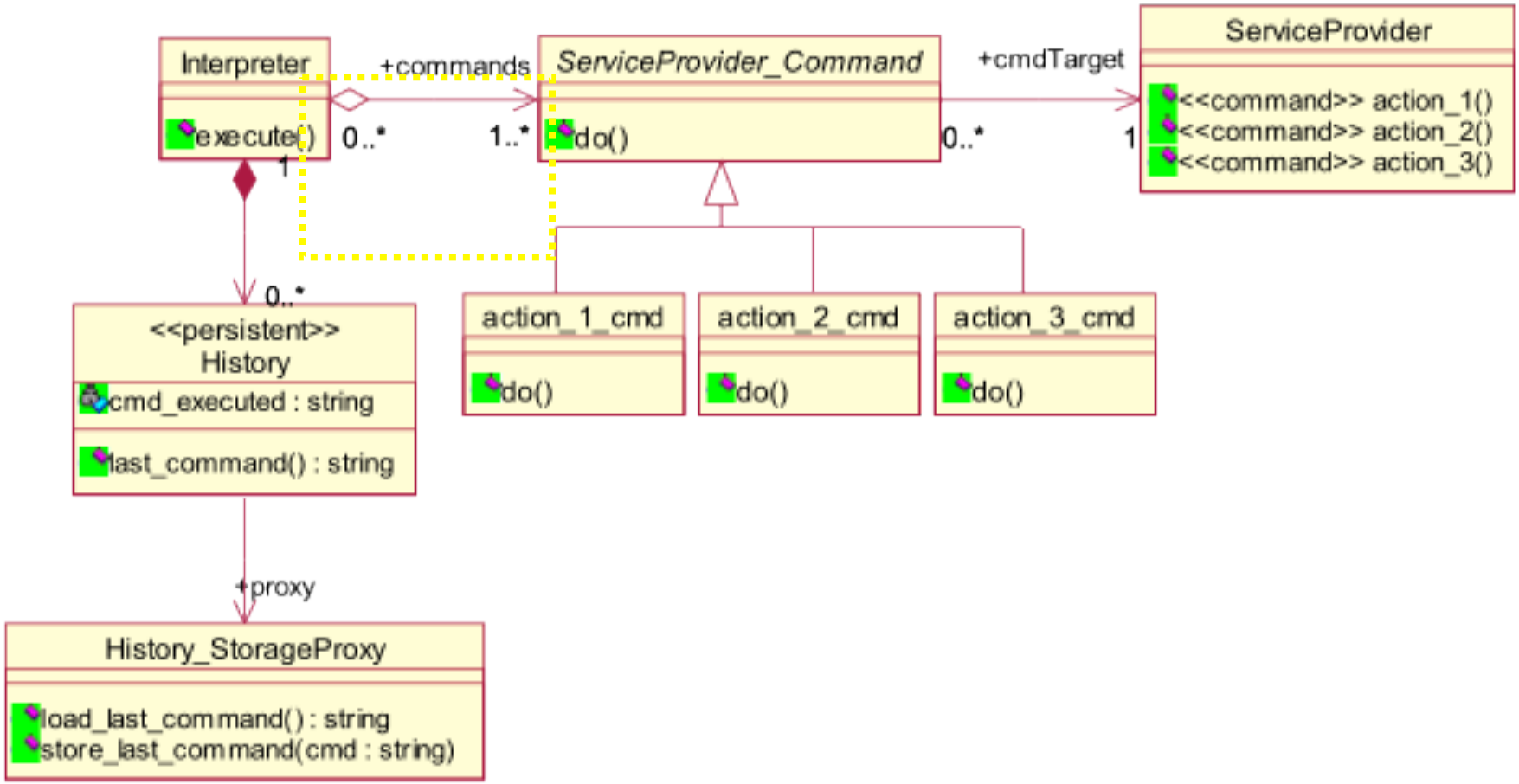
Design pattern application
(parametric collaboration)



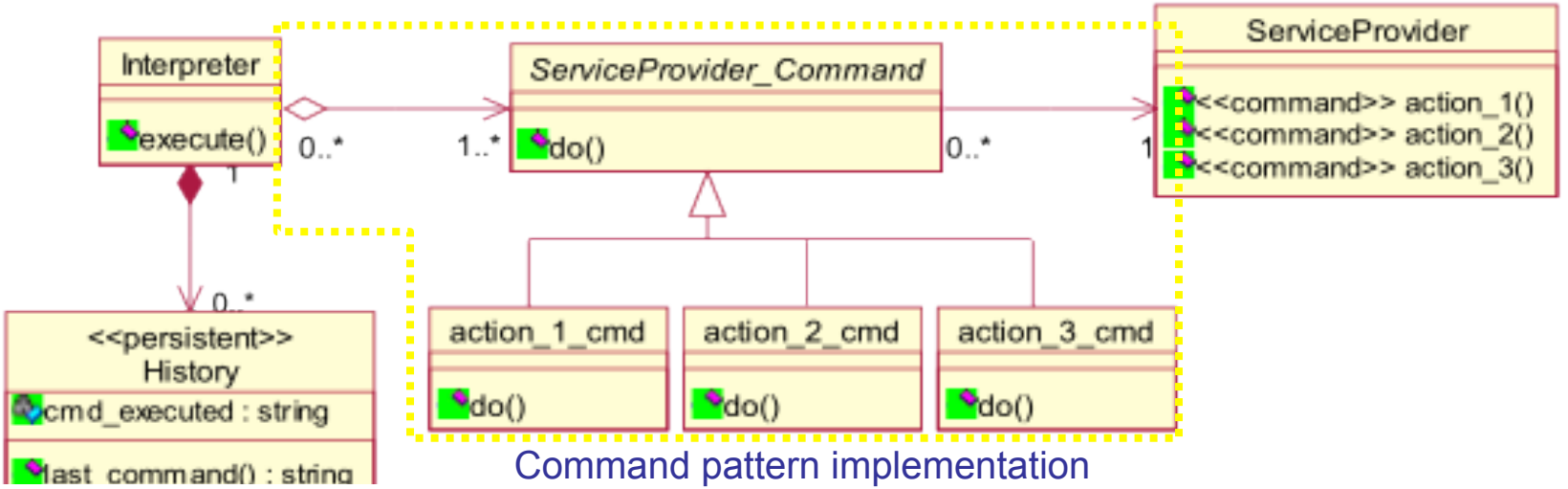
Element stereotype

…and also
Tagged values
& Contracts

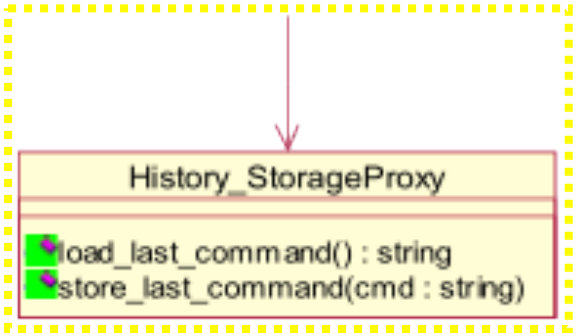
…and the result we want...



How To:
Automatic Model Transformations



Command pattern implementation



Persitence implementation

In some domains (e.g.; RT systems)
transformations can get more complex
than initial model!
=> must be managed with sound SE principles

Quizz Time

#7 e9a8d603

Give an example of model-to-text transformation

Give an example of model-to-model transformation

Quizz Time

#8 e9a8d603

Give an example of endogenerous transformation

Give an example of exogeneous transformation

Quizz Time

#9 e9a8d603

Give an example of vertical transformation

Give an example of horizontal transformation

Xtend

A possible solution
for
model management

Effective Model Management

- How to load/serialize a model?
- How to visit, analyze and transform models?
- You can do it in Java (EMF API)

- We arbitrarily choose 

  - Java 10, interesting « features »
  - Integration within Eclipse ecosystem (incl. Xtext) and facilities to manage models
  - An example of a sophisticated language

Before going into details of Xtend…

- Recap of the scenarios
  - Text-to-Model
  - Model(s)-to-Model transformation
  - Metamodels as a « bridge » between techologies
  - Model-to-Text
- The solution of some of the « scenarios »
  - Just to give an overview of Xtend capabilities
  - To give a more practical/concrete view of some of the previous scenarios

```
def loadPollSystem(URI uri) {
    new QuestionnaireStandaloneSetupGenerated().createInjectorAndDoEMFRegistration()
    var res = new ResourceSetImpl().getResource(uri, true);
    res.contents.get(0) as PollSystem
}
```

```
def savePollSystem(URI uri, PollSystem pollS) {
    var Resource rs = new ResourceSetImpl().createResource(uri);
    rs.getContents.add(pollS);
    rs.save(new HashMap());
}
```

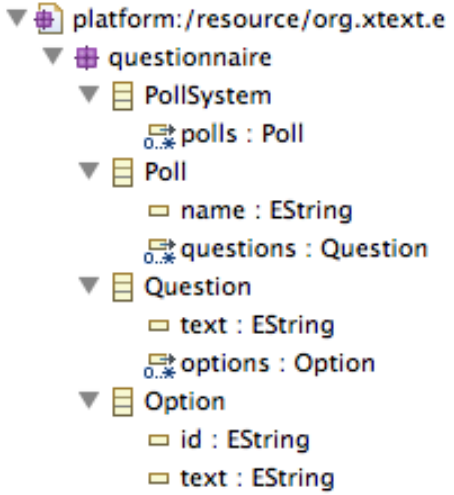
```
@Test
def test1() {

    // loading
    var pollS = loadPollSystem(URI.createURI("foo1.q"))
    assertNotNull(pollS)
    assertEquals(2, pollS.polls.size)

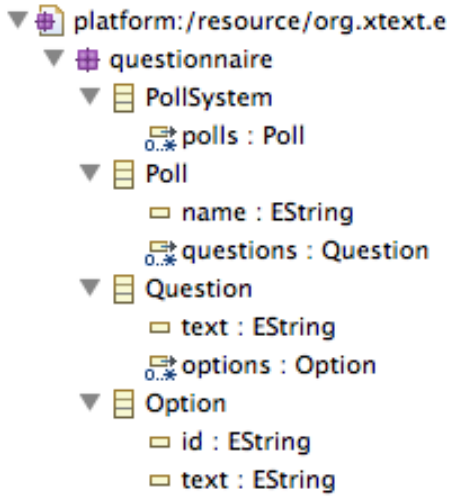
    // MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
    pollS.polls.forEach[p | p.name = p.name + "_poll"]

    // serializing
    savePollSystem(URI.createURI("foo2.q"), pollS)

}
```



Loading Models (1)



foo1.q

```
PollSystem {

    Poll poll1 {

        Question A {
            "What is A ?"
            options
                b : "B"
                c : "C"
                d : "D"

        }

    }

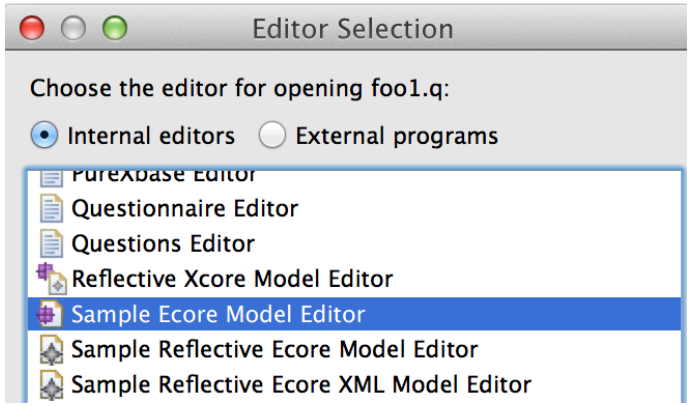
    Poll poll2 {

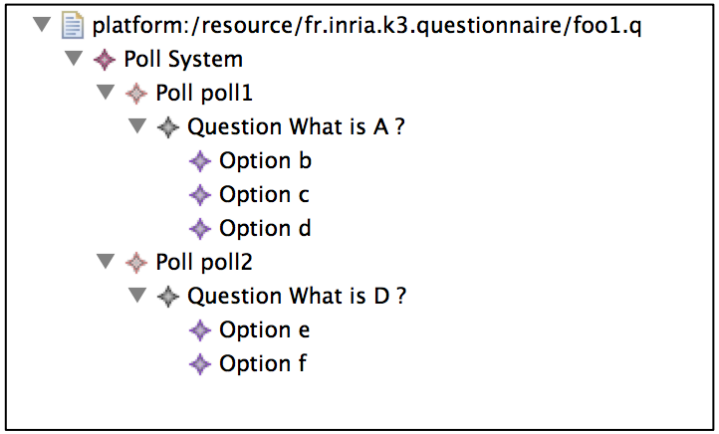
        Question D {
            "What is D ?"
            options
                e : "E"
                f : "F"

        }

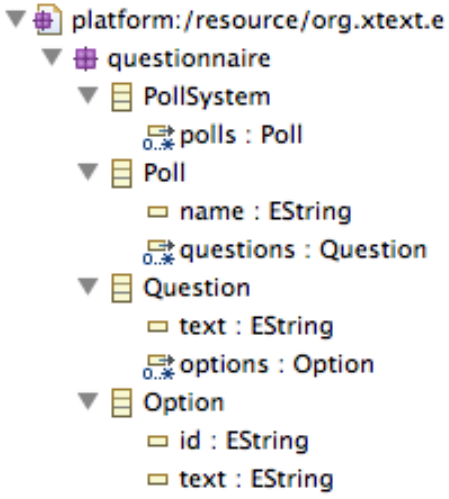
    }

}
```





Loading Models (2)



foo1.q

```
PollSystem {

    Poll poll1 {

        Question A {
            "What is A ?"
            options
                b : "B"
                c : "C"
                d : "D"

        }

    }

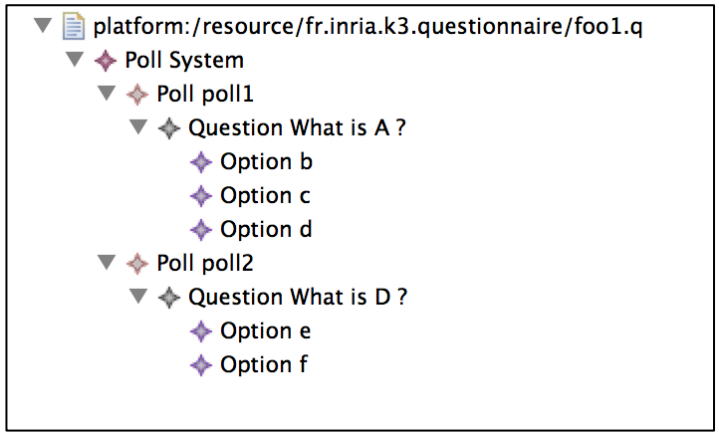
    Poll poll2 {

        Question D {
            "What is D ?"
            options
                e : "E"
                f : "F"

        }

    }

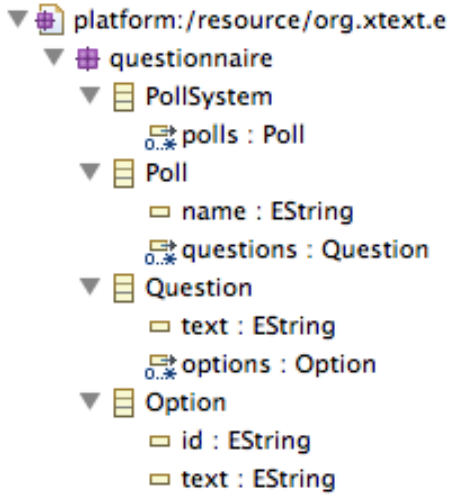
}
```



XMI

```
<?xml version="1.0" encoding="ASCII"?>
<questionnaire:PollSystem xmi:version="2.0"
xmlns:xmi="http://www.omg.org/XMI"
xmlns:questionnaire="http://www.xtext.org/example/mya
  <polls name="poll1">
    <questions text="What is A ?">
      <options id="b" text="B"/>
      <options id="c" text="C"/>
      <options id="d" text="D"/>
    </questions>
  </polls>
  <polls name="poll2">
    <questions text="What is D ?">
      <options id="e" text="E"/>
      <options id="f" text="F"/>
    </questions>
  </polls>
</questionnaire:PollSystem>
```

Loading Models (3)



foo1.q

```
PollSystem {

    Poll poll1 {

        Question A {
            "What is A ?"
            options
                    b : "B"
                    c : "C"
                    d : "D"

        }

    }

    Poll poll2 {

        Question D {
            "What is D ?"
            options
                    e : "E"
                    f : "F"

        }

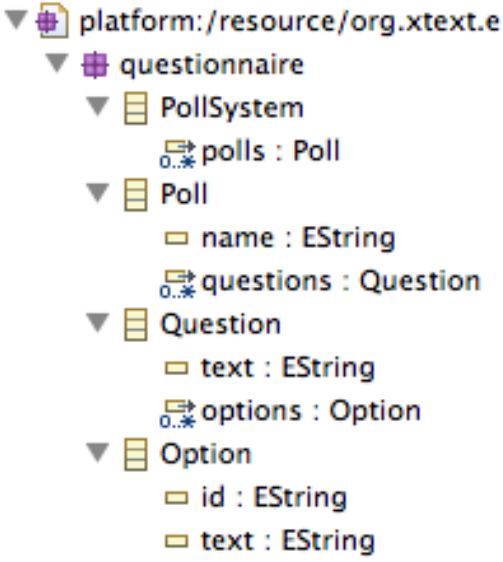
    }

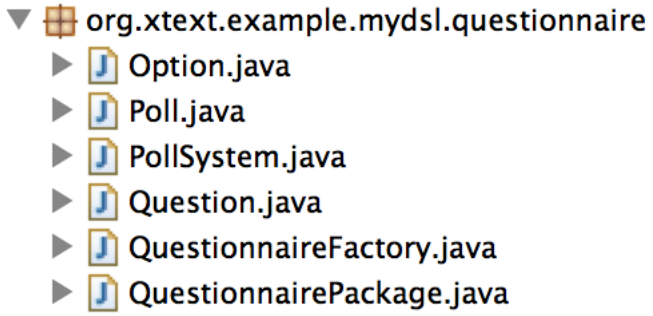
}
```

Persistence of Models in XMI (XML Metadata Interchange)

```
<?xml version="1.0" encoding="ASCII"?>
<questionnaire:PollSystem xmi:version="2.0"
xmlns:xmi="http://www.omg.org/XMI"
xmlns:questionnaire="http://www.xtext.org/example/mydsl/Questionnaire">
  <polls name="poll1">
    <questions text="What is A ?">
      <options id="b" text="B"/>
      <options id="c" text="C"/>
      <options id="d" text="D"/>
    </questions>
  </polls>
  <polls name="poll2">
    <questions text="What is D ?">
      <options id="e" text="E"/>
      <options id="f" text="F"/>
    </questions>
  </polls>
</questionnaire:PollSystem>
```

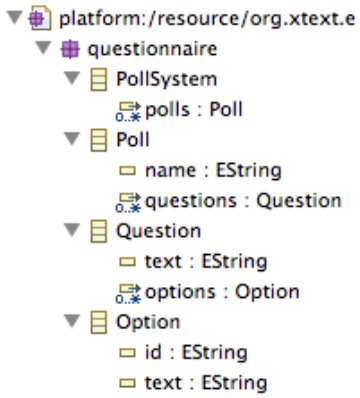
Meta(models) and Java

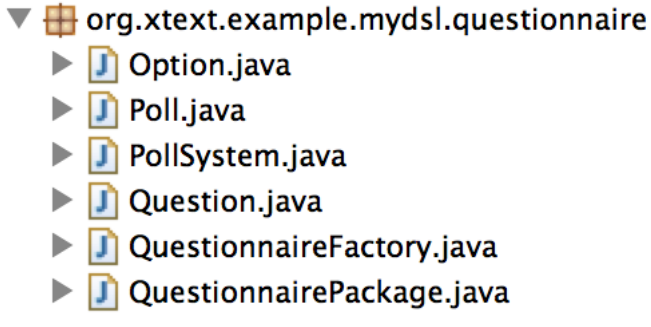





```java
public interface Poll extends EObject
{
  /**
   * Returns the value of the '<em><b>Name</b></em>' attribute.
   * <!-- begin-user-doc -->
   * <p>
   * If the meaning of the '<em>Name</em>' attribute isn't clear,
   * there really should be more of a description here...
   * </p>
   * <!-- end-user-doc -->
   * @return the value of the '<em>Name</em>' attribute.
   * @see #setName(String)
   * @see org.xtext.example.mydsl.questionnaire.QuestionnairePackage#getPoll_Name()
   * @model
   * @generated
   */
  String getName();

  /**
   * Sets the value of the '{@link org.xtext.example.mydsl.questionnaire.Poll#getName <em>Name</em>}'
   * <!-- begin-user-doc -->
   * <!-- end-user-doc -->
   * @param value the new value of the '<em>Name</em>' attribute.
   * @see #getName()
   * @generated
   */
  void setName(String value);

  /**
   * Returns the value of the '<em><b>Questions</b></em>' containment reference list.
   * The list contents are of type {@link org.xtext.example.mydsl.questionnaire.Question}.
   * <!-- begin-user-doc -->
   * <p>
   * If the meaning of the '<em>Questions</em>' containment reference list isn't clear,
   * there really should be more of a description here...
   * </p>
   * <!-- end-user-doc -->
   * @return the value of the '<em>Questions</em>' containment reference list.
   * @see org.xtext.example.mydsl.questionnaire.QuestionnairePackage#getPoll_Questions()
   * @model containment="true"
   * @generated
   */
  EList<Question> getQuestions();

} // Poll
```

Meta(models) and Java





```
public interface Poll extends EObject
{
  /**
   * Returns the value of the '<em><b>Name</b></em>' attribute.
   * <!-- begin-user-doc -->
   * <p>
   * If the meaning of the '<em>Name</em>' attribute isn't clear,
   * there really should be more of a description here...
   * </p>
   * <!-- end-user-doc -->
   * @return the value of the '<em>Name</em>' attribute.
   * @see #setName(String)
   * @see org.xtext.example.mydsl.questionnaire.QuestionnairePackage#getPoll_Name()
   * @model
   * @generated
   */
  String getName();

  /**
   * Sets the value of the '{@link org.xtext.example.mydsl.questionnaire.Poll#getName <em>Name</em>}' attribute.
   * <!-- begin-user-doc -->
   * <!-- end-user-doc -->
   * @param value the new value of the '<em>Name</em>' attribute.
   * @see #getName()
   * @generated
   */
  void setName(String value);

  /**
   * Returns the value of the '<em><b>Questions</b></em>' containment reference list.
   * The list contents are of type {@link org.xtext.example.mydsl.questionnaire.Question}.
   * <!-- begin-user-doc -->
   * <p>
   * If the meaning of the '<em>Questions</em>' containment reference list isn't clear,
   * there really should be more of a description here...
   * </p>
   * <!-- end-user-doc -->
   * @return the value of the '<em>Questions</em>' containment reference list.
   * @see org.xtext.example.mydsl.questionnaire.QuestionnairePackage#getPoll_Questions()
   * @model containment="true"
   * @generated
   */
  EList<Question> getQuestions();

} // Poll
```

```
foo1.q
PollSystem {

    Poll poll1 {

        Question A {
            "What is A ?"
            options
                b : "B"
                c : "C"
                d : "D"

        }

    }

    Poll poll2 {

        Question D {
            "What is D ?"
            options
                e : "E"
                f : "F"

        }

    }

}
```

« Eclipse Modeling Framework (EMF) runtime support to produce a set of Java classes for the model »

http://eclipsesource.com/blogs/tutorials/emf-tutorial/

Ecore Model

Java Code

Code generation

EPackage
EClass
EAttribute
EReference

Package
Class
Attribute
Reference

foo1.q

```
PollSystem {

    Poll poll1 {

        Question A {
            "What is A ?"
            options
                b : "B"
                c : "C"
                d : "D"

        }

    }

    Poll poll2 {

        Question D {
            "What is D ?"
            options
                e : "E"
                f : "F"

        }

    }

}
```

```
def loadPollSystem(URI uri) {
    new QuestionnaireStandaloneSetupGenerated().createInjectorAndDoEMFRegistration()
    var res = new ResourceSetImpl().getResource(uri, true);
    res.contents.get(0) as PollSystem
}

def savePollSystem(URI uri, PollSystem poll5) {
    var Resource rs = new ResourceSetImpl().createResource(uri);
    rs.getContents.add(poll5);
    rs.save(new HashMap());
}

@Test
def test1() {

    // loading
    var poll5 = loadPollSystem(URI.createURI("foo1.q"))
    assertNotNull(poll5)
    assertEquals(2, poll5.polls.size)

    // MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
    poll5.polls.forEach[p | p.name = p.name + "_poll"]

    // serializing
    savePollSystem(URI.createURI("foo2.q"), poll5)

}
```

foo1.q foo2.q

```
PollSystem {

    Poll poll1_poll {

        Question {
            "What is A ?"
            options
                b : "B"
                c : "C"
                d : "D"

        }

    }

    Poll poll2_poll {

        Question {
            "What is D ?"
            options
                e : "E"
                f : "F"

        }

    }

}
```

Questionnaire MM (ecore)

Questionnaire MM (ecore)

Questionnaire Model 1 (xmi)

Questionnaire Model 2 (xmi)

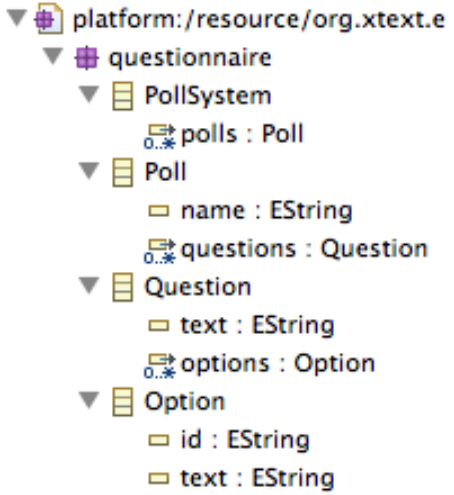
```
PollSystem {
    Poll Quality {
        Question q1 {
            "Value the user experience"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
        Question q2 {
            "Value the layout"
            options {
                A : "It was not easy to locate elements"
                B : "I didn't realize"
                C : "It was easy to locate elements"
            }
        }
    }
    Poll Performance {
        Question q1 {
            "Value the time response"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
    }
}
```

```
PollSystem {
    Poll Quality {
        Question q1 {
            "Value the user experience"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
        Question q2 {
            "Value the layout"
            options {
                A : "It was not easy to locate elements"
                B : "I didn't realize"
                C : "It was easy to locate elements"
            }
        }
    }
    Poll Performance {
        Question q1 {
            "Value the time response"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
    }
}
```

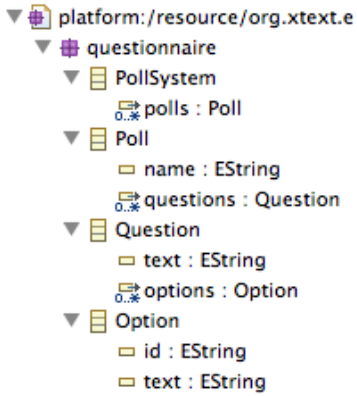
```
def loadPollSystem(URI uri) {
    new QuestionnaireStandaloneSetupGenerated().createInjectorAndDoEMFRegistration()
    var res = new ResourceSetImpl().getResource(uri, true);
    res.contents.get(0) as PollSystem
}
```

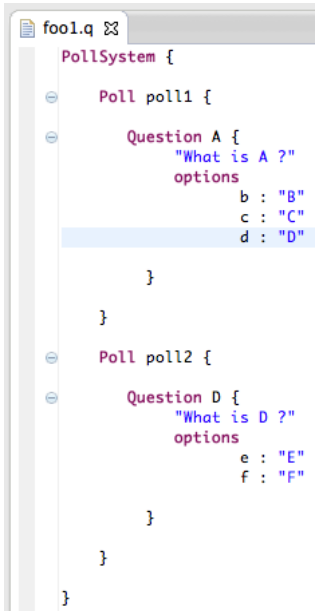
```
def savePollSystem(URI uri, PollSystem pollS) {
    var Resource rs = new ResourceSetImpl().createResource(uri);
    rs.getContents.add(pollS);
    rs.save(new HashMap());
}
```

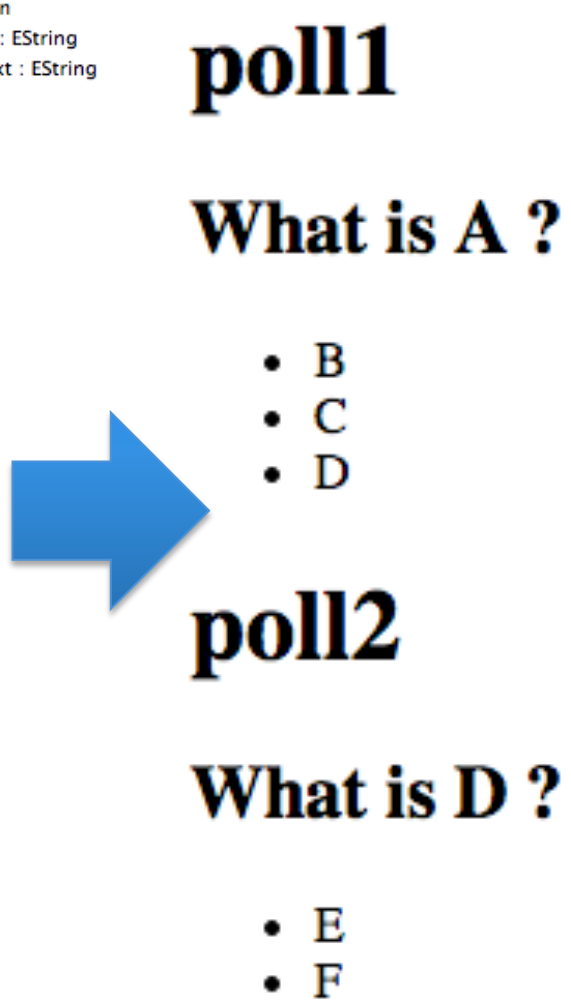
```
@Test
def test1() {

    // loading
    var pollS = loadPollSystem(URI.createURI("foo1.q"))
    assertNotNull(pollS)
    assertEquals(2, pollS.polls.size)

    // MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
    pollS.polls.forEach[p | p.name = p.name + "_poll"]

    // serializing
    savePollSystem(URI.createURI("foo2.q"), pollS)

}
```



```
@Test
def test2() {

// loading
var pollS = loadPollSystem(URI.createURI("foo1.q"))

// MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
var html = toPolls(pollS.polls)
assertNotNull(html)

// serializing (note: we could type check the HTML
// with Xtext by specifying the grammar for instance)
val fw = new FileWriter("foo1.html")
fw.write(html.toString)
fw.close


}

def toPolls(List<Poll> polls) '''
  <html>
    <body>
      «FOR p : polls»
        «IF p.name != null»
          <h1>«p.name»</h1>
        «ENDIF»
        «FOR q : p.questions»
        <p>
            <h2>«q.text»</h2>
            <ul>
             «FOR o : q.options»
             <li>«o.text»</li>
             «ENDFOR»
            </ul>
        </p>
        «ENDFOR»
      «ENDFOR»
    </body>
  </html>
'''
```







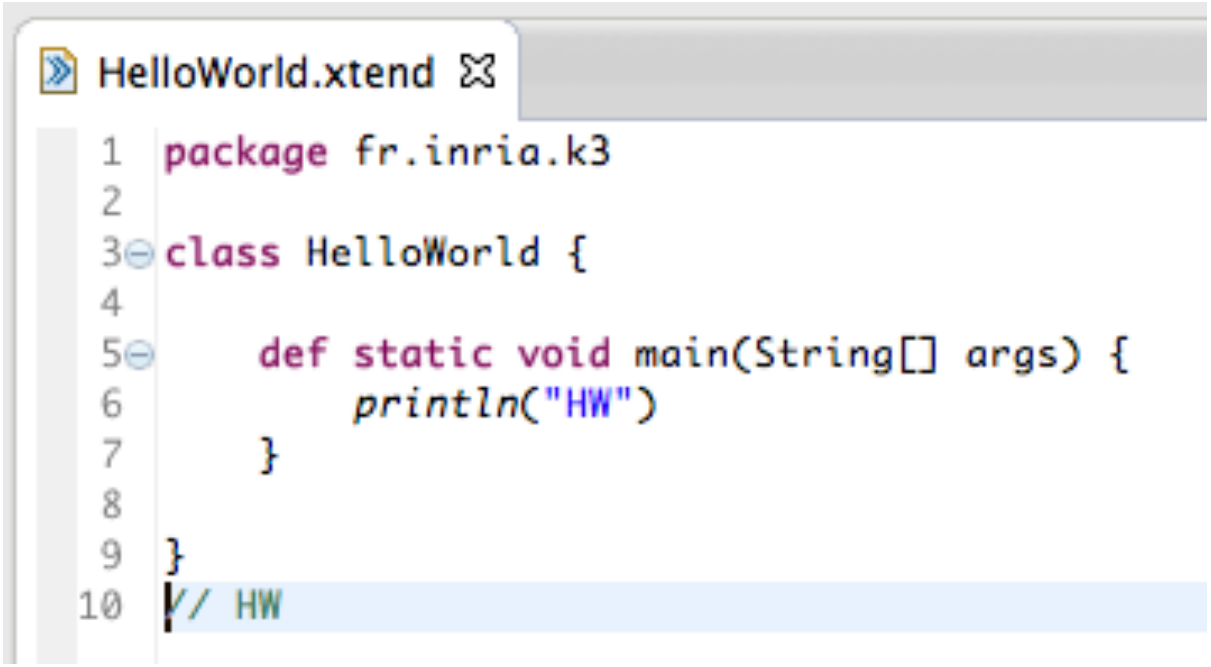
Contract

- Practical foundations of model management
- Learning and understanding Java 10 (aka Xtend)
  - advanced features of a general GPL, implementation of a sophisticated language using MDE
- Model transformations
  - Model-to-Text
  - Model-to-Model
- Metaprogramming
  - Revisit annotations (e.g., as in JPA or many frameworks)
- DSLs and model management: all together (Xtext + Xtend)

Xtend

The Basics
(~ Java cheatsheet)

Hello World


HelloWorld.xtend
1 package fr.inria.k3
2
3 class HelloWorld {
4
5 def static void main(String[] args) {
6 println("HW")
7 }
8
9 }
10 // HW

Semi-colon is optional (within class, methods, etc.)

```
1  package fr.inria.k3.fields
2
3  class MyFielder {
4
5    int count = 1
6    static boolean debug = false
7    var name = 'Foo'            // type String is inferred
8    val UNIVERSAL_ANSWER = 42 // final field with inferred type int
9    // ...
10   public int count2 = 2 ;
11
12 }
13
```

Package Declaration

HelloWorld.xtend

```
1  package fr.inria.k3
2
3  class HelloWorld {
4
5      def static void main(String[] args) {
6          println("HW")
7      }
8
9  }
10 // HW
```

Semi-colon ‘;’ is optional

HelloWorld.xtend | HelloWorld.java | PackageExploder.xtend

```
1  package fr.inria.k3.^def
2
3  class PackageExploder {
4
5  }
```

‘^’ for avoiding keyword conflicts

Methods

```
1  package fr.inria.k3.methods
2
3  class FooMethod {
4
5      def foo1() {
6          "A"
7      }
8
9      def foo2() {
10         6 + 3
11     }
12
13     def private foo3() {
14         6 + 3
15     }
16
17     def public foo4() {
18         foo3() * 8
19     }
20 }
21
22 class FooMethodUses {
23
24     def fooUse() {
25         new FooMethod().foo1
26         new FooMethod().foo3()
27
28
29
30         new FooMethod().f
31
32
33     }
34
35 }
```

```
foo1 : String - FooMethod.foo1()
foo2 : int - FooMethod.foo2()
foo4 : int - FooMethod.foo4()
```

By default: visibility conditions set to public

HelloWorld.xtend

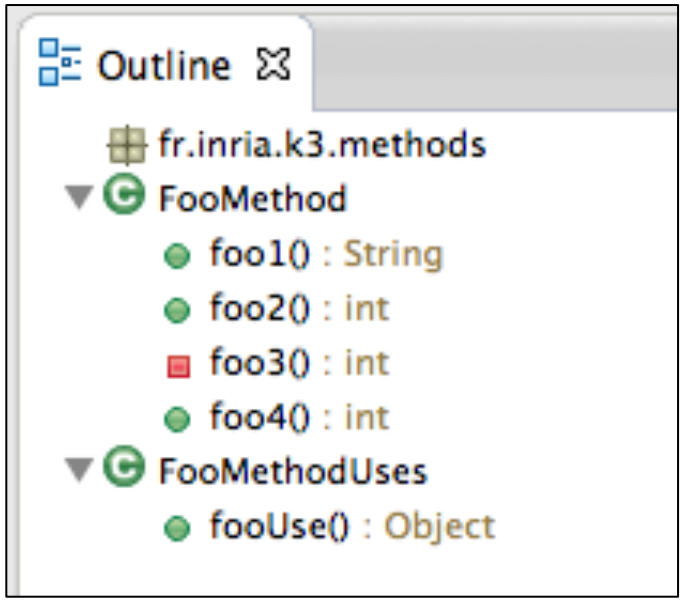
```
1  package fr.inria.k3
2
3  class HelloWorld {
4
5      def static void main(String[] args) {
6          println("HW")
7      }
8
9  }
10 // HW
```

Methods

```
1  package fr.inria.k3.methods
2
3  class FooMethod {
4
5      def foo1() {
6          "A"
7      }
8
9      def foo2() {
10         6 + 3
11     }
12
13     def private foo3() {
14         6 + 3
15     }
16
17     def public foo4() {
18         foo3() * 8
19     }
20 }
21
22 class FooMethodUses {
23
24     def fooUse() {
25         new FooMethod().foo1
26         new FooMethod().foo3()
27
28
29
30         new FooMethod().f
31
32
33     }
34
35 }
```

```
foo1 : String - FooMethod.foo1()
foo2 : int - FooMethod.foo2()
foo4 : int - FooMethod.foo4()
```

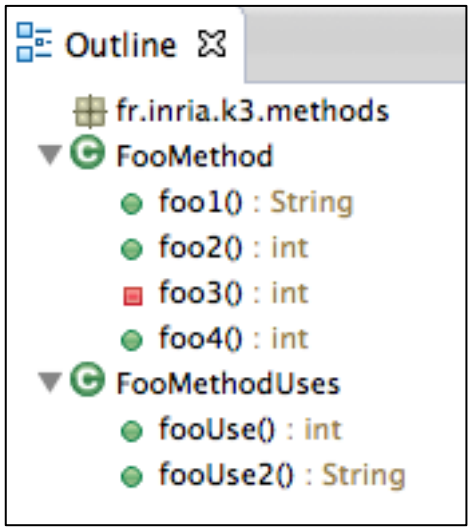
Type inference (return type)



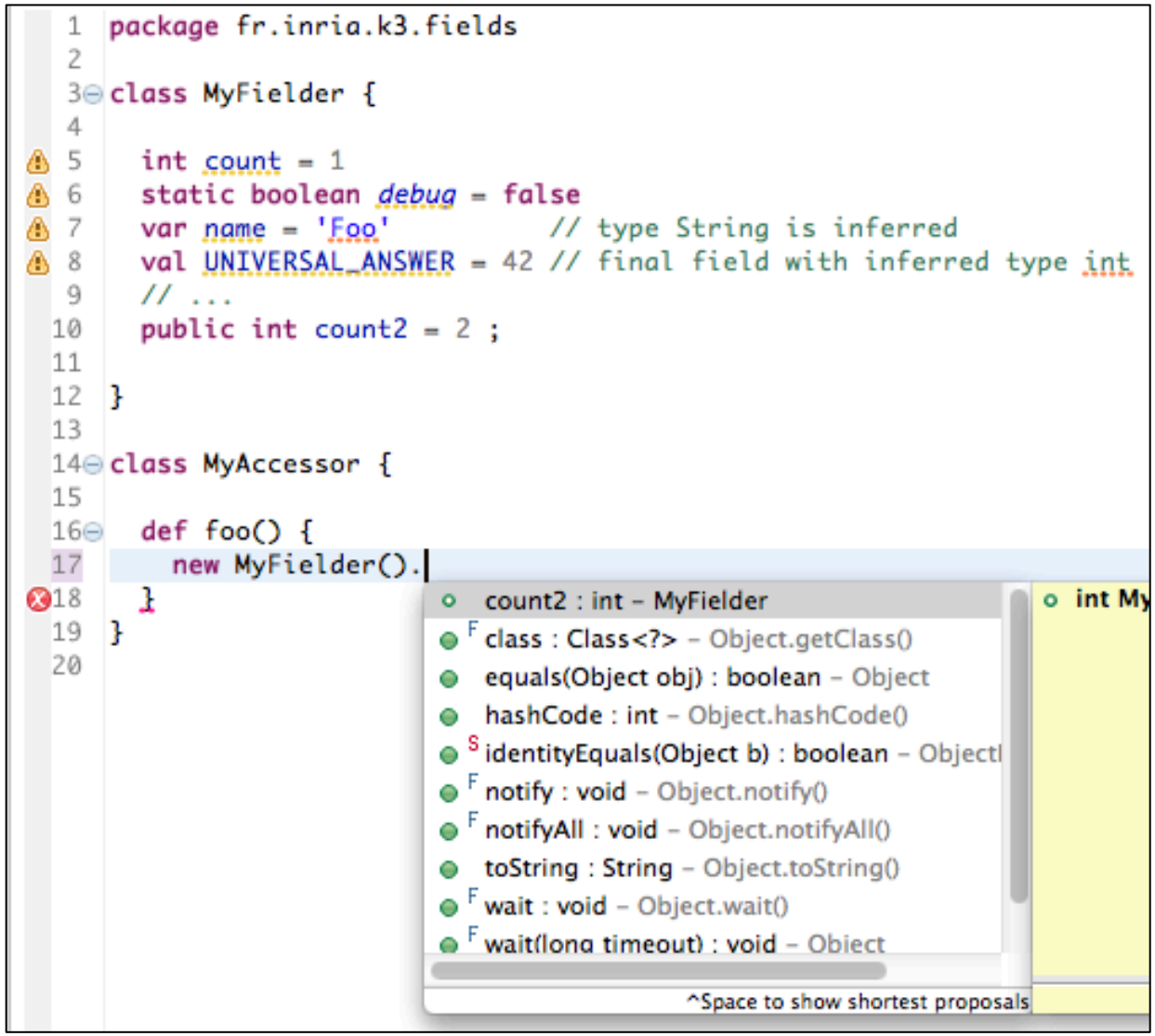
Method Calling

You can ommit parentheses

```
33    def fooUse2() {
34        3.toString
35        "4".length
36        new FooMethod().foo1
37        new FooMethod().foo1()
38        new FooMethod().foo1 + 3.toString
39
40    }
```



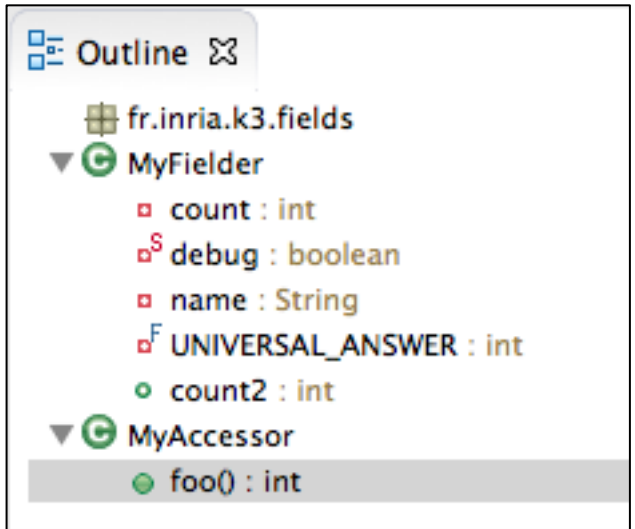
Fields



By default: visibility conditions set to private

Fields

```
1  package fr.inria.k3.fields
2
3  class MyFielder {
4
5    int count = 1
6    static boolean debug = false
7    var name = 'Foo'           // type String is inferred
8    val UNIVERSAL_ANSWER = 42 // final field with inferred type int
9    // ...
10   public int count2 = 2 ;
11
12 }
13
```



primitive types of Java (int, boolean, etc) with autoboxing

var: type inference

val: constant, « final » in Java

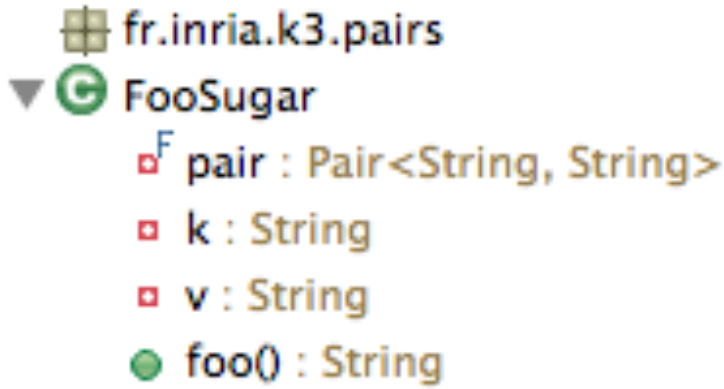
Static Methods (::)

```
1  package fr.inria.k3.stat
2
3  import java.util.Collections
4
5  class FooStati {
6
7
8      static var colors = newArrayList(46, 76, 89, 53)
9
10
11     def static void main(String... args) {
12         println("B " + colors)
13         Collections::sort(colors)
14         println("A " + colors)
15
16         colors.add(45)
17         println("A " + colors)
18
19     }
20 }
```

```
B [46, 76, 89, 53]
A [46, 53, 76, 89]
A [46, 53, 76, 89, 45]
```

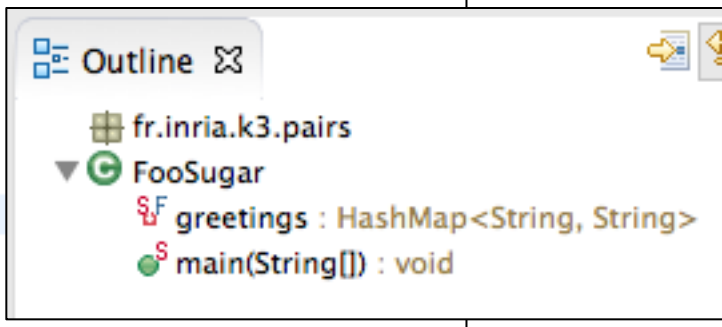
Pairs

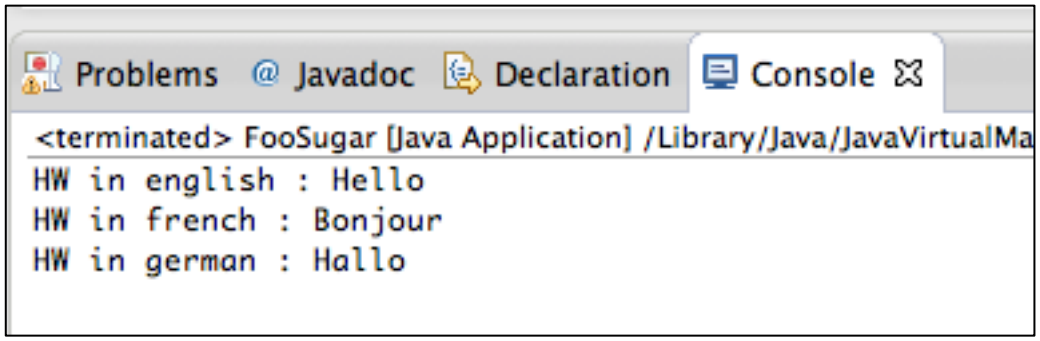
```
1  package fr.inria.k3.pairs
2
3  class FooSugar {
4
5      // syntactic sugar
6      val pair = "spain" -> "italy"
7      var k = pair.key
8      var v = pair.value
9
10     def foo() {
11
12         println("key=" + k + " value=" + v)
13
14     }
15 }
```



Pairs

```
1  package fr.inria.k3.pairs
2
3  class FooSugar {
4
5
6      static val greetings = newHashMap(
7      "german"  -> "Hallo",
8      "english" -> "Hello",
9      "french" -> "Bonjour"
10     )
11
12     def static main(String... args) {
13         greetings.forEach[key, value | println("HW in " + key + " : " + value)]
14
15     }
16 }
```





Immutable data structure

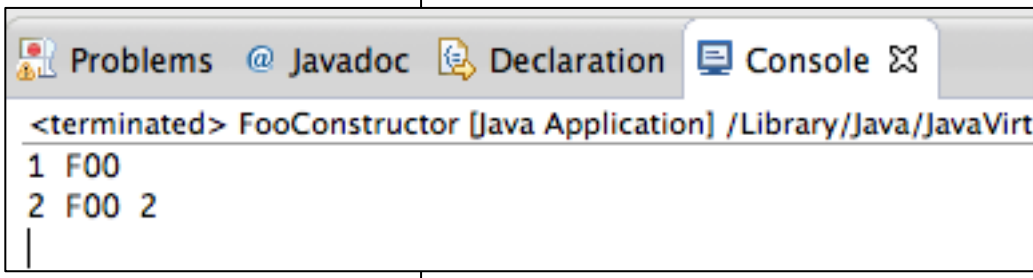
```
1  package fr.inria.k3.stat
2
3  import java.util.Collections
4
5  class FooStati {
6
7
8      static var colors = #[46, 76, 89, 53] // newArrayList(46, 76, 89, 53)
9
10
11     def static void main(String... args) {
12         println("B " + colors)
13         Collections::sort(colors)
14         println("A " + colors)
15
16         colors.add(45)
17         println("A " + colors)
18
19     }
20 }
```

```
<terminated> FooStati [Java Application] /Library/Java/JavaVirtualMachines/jdk1.7.0_13.jdk/Contents/H
B [46, 76, 89, 53]
Exception in thread "main" java.lang.UnsupportedOperationException
        at java.util.Collections$UnmodifiableList$1.set(Collections.java:1244)
        at java.util.Collections.sort(Collections.java:159)
        at fr.inria.k3.stat.FooStati.main(FooStati.java:15)
```

Constructor

Default visibility: public

```
1  package fr.inria.k3.classes
2
3  class FooConstructor {
4
5      var String l
6
7      new() {
8          this("FOO")
9      }
10
11     new (String v) {
12         l = v
13     }
14
15
16     override toString() {
17         l
18     }
19
20     def static void main (String... args) {
21         println("1 " + new FooConstructor())
22         println("2 " + new FooConstructor("FOO 2"))
23     }
24 }
```



override keyword: mandatory

Cast and Type

```
1  package fr.inria.k3.types
2
3  class FooTypes {
4
5      static val Object obj = "a string"
6      // static val String s = obj
7      static val String s = obj as String // cast
8
9      def static void main(String... args) {
10         println(typeof(String) + "") // String.class
11         println("\t" + s + "\n")
12
13     }
14 }
```

Extension Methods…

« … allow to add new methods to existing types without modifying them. »

```
def removeVowels (String s){
  s.replaceAll("[aeiouAEIOU]", "")
}
```

We can call this method either like in Java:

```
removeVowels("Hello")
```

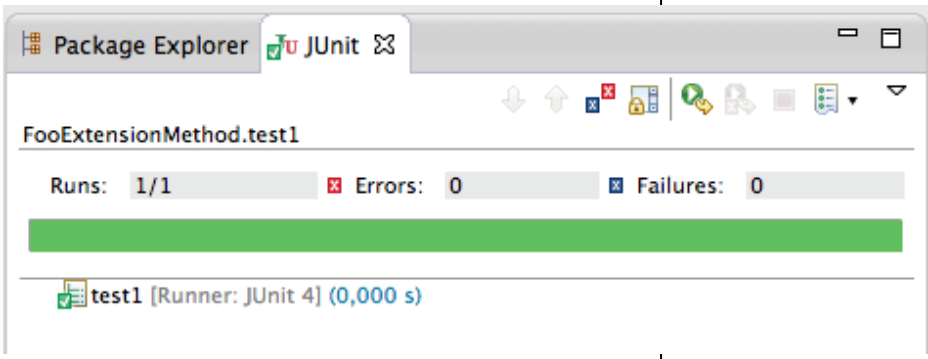
or as an extension method of String:

```
"Hello".removeVowels
```

The first parameter of a method can either be passed in after opening the parentheses or before the method call

Extension Method (local)

```
1  package fr.inria.k3.methods
2
3  import org.junit.Test
4  import static org.junit.Assert.*
5
6  class FooExtensionMethod {
7
8
9      def removeVowels (String s){
10         s.replaceAll("[aeiouAEIOU]", "")
11     }
12
13     def foo() {
14         "HelloWorld".removeVowels
15     }
16
17     @Test
18     def test1() {
19         assertEquals("HllWrld", new FooExtensionMethod().foo)
20     }
21 }
```



Extension Method (library)

```
1  package fr.inria.k3.methods
2
3  import org.junit.Test
4
5  import static org.junit.Assert.*
6
7  class FooExtensionLibrary {
8
9      var listOfStrings = #["A", "b", "c", "D", "e"]
10
11     def foo() {
12         var String h = "hello".toFirstUpper // calls StringExtensions.toFirstUpper(String)
13         listOfStrings.map[ toUpperCase ] // calls ListExtensions.<T, R>map(List<T> list, Function<? super T, ? extends R> mapFunction)
14
15     }
16
17     @Test
18     def test1() {
19         assertEquals("C", new FooExtensionLibrary().foo.get(2))
20     }
21 }
```

```
/**
 * Returns a list that performs the given {@code transformation} for each element of {@code original} when
 * requested. The mapping is done lazily. That is, subsequent iterations of the elements in the list will
 * repeatedly apply the transformation. The returned list is a transformed view of {@code original}; changes to
 * {@code original} will be reflected in the returned list and vice versa (e.g. invocations of {@link List#remove(int)}).
 *
 *
 * @param original
 *            the original list. May not be <code>null</code>.
 * @param transformation
 *            the transformation. May not be <code>null</code>.
 * @return a list that effectively contains the results of the transformation. Never <code>null</code>.
 */
@Pure
public static <T, R> List<R> map(List<T> original, Function1<? super T, ? extends R> transformation) {
    return Lists.transform(original, new FunctionDelegate<T, R>(transformation));
}
```

```
public class ListExtensions {
```

Extension Method (library)

```
1  package fr.inria.k3.methods
2
3  import org.junit.Test
4
5  import static org.junit.Assert.*
6
7  class FooExtensionLibrary {
8
9      var listOfStrings = #["A", "b", "c", "D", "e"]
10
11     def foo() {
12         var String h = "hello".toFirstUpper // calls StringExtensions.toFirstUpper(String)
13         listOfStrings.map[ toUpperCase ] // calls ListExtensions.<T, R>map(List<T> list, Function<? super T, ? extends R> mapFunction)
14
15     }
16
17     @Test
18     def test1() {
19         assertEquals("C", new FooExtensionLibrary().foo.get(2))
20     }
21 }
```

```
/**
 * Returns the {@link String} {@code s} with an {@link Character#isUpperCase(char) upper case} first character. This
 * function is null-safe.
 *
 * @param s
 *            the string that should get an upper case first character. May be <code>null</code>.
 * @return the {@link String} {@code s} with an upper case first character or <code>null</code> if the input
 *         {@link String} {@code s} was <code>null</code>.
 */
@Pure
public static String toFirstUpper(String s) {
    if (s == null || s.length() == 0)
        return s;
    if (Character.isUpperCase(s.charAt(0)))
        return s;
    if (s.length() == 1)
        return s.toUpperCase();
    return s.substring(0, 1).toUpperCase() + s.substring(1);
}
```

```
public class StringExtensions {
```

Lambda Expression
(Java 8 will support it)

Anonymous classes can be found everywhere in Java code…

```
1.  // Java Code!
2.  final JTextField textField = new JTextField();
3.  textField.addActionListener(new ActionListener() {
4.    @Override
5.    public void actionPerformed(ActionEvent e) {
6.      textField.setText("Something happened!");
7.    }
8.  });
```

… And have always been the poor-man's replacement for lambda expressions in Java.

Lambda Expression
(Xtend answer)

Anonymous classes can be found everywhere in Java code…

```
1.  // Java Code!
2.  final JTextField textField = new JTextField();
3.  textField.addActionListener(new ActionListener() {
4.    @Override
5.    public void actionPerformed(ActionEvent e) {
6.      textField.setText("Something happened!");
7.    }
8.  });
```

No need to specify the type for e

```
1.  textField.addActionListener([ e |
2.    textField.text = "Something happened!"
3.  ])
```

You can even ommit e

```
1.  textField.addActionListener([
2.    textField.text = "Something happened!"
3.  ])
```

Lambda Expression

(Xtend answer, more impressive examples)

```
1.  Collections.sort(someStrings) [ a, b |
2.    a.length - b.length
3.  ]
```

Java 8:

```
shapes.forEach(s -> { s.setColor(RED); });
```

Xtend:

```
shapes.forEach[color = RED]
```

Java 8:

```
shapes.stream()
      .filter(s -> s.getColor() == BLUE)
      .forEach(s -> { s.setColor(RED); });
```

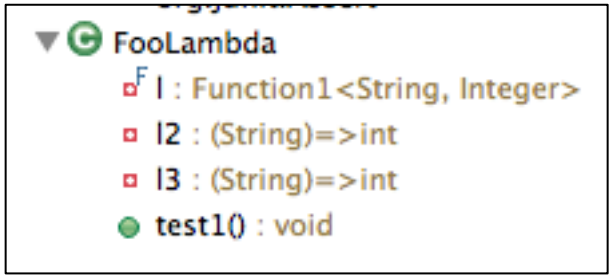
Xtend:

```
shapes.stream
      .filter[color == BLUE]
      .forEach[color = RED]
```

Lambda Expression

(Xtend answer, more impressive examples)

```
class FooLambda {

    val l = [String s | s.length]
    var (String)=>int l2 = [it.length] // it is a keyword for refering to the first parameter
    var (String)=>int l3 = [length] // we can even ommit it or the first parameter

    @Test
    def test1() {
        assertEquals(l.apply ("RRRR"), l2.apply("PPPP"))
        assertEquals(l2.apply ("RRRR"), l3.apply("PPPP"))
    }
}
```

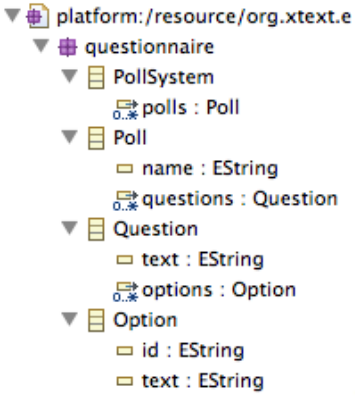


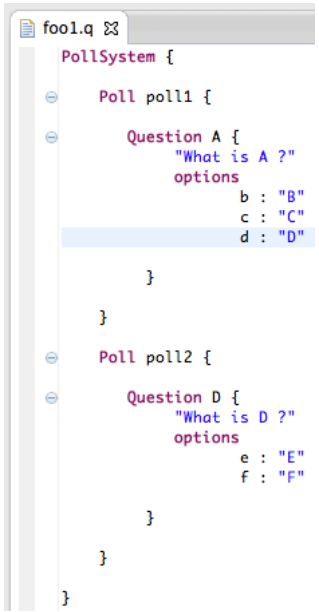
Templates

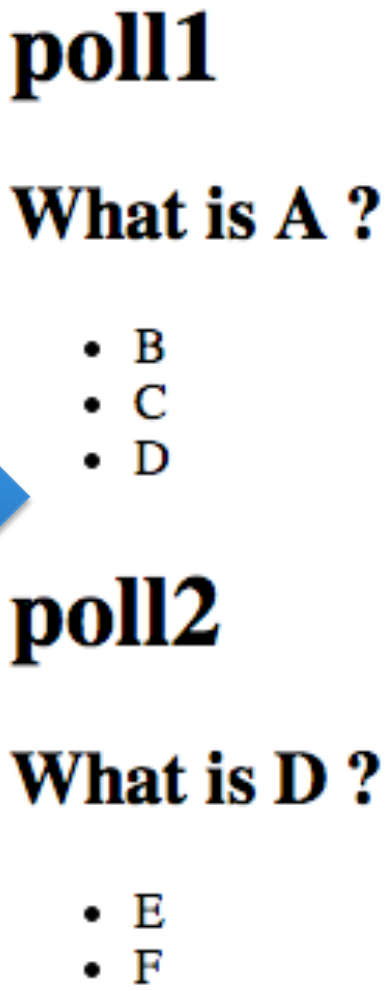
```
1  package fr.inria.k3.templates
2
3  import org.junit.Test
4  import static org.junit.Assert.*
5
6  class FooTempl {
7
8
9      def someHTML(String content) '''<html><body>«content»</body></html>'''
10
11
12     @Test
13     def test1() {
14         assertEquals("<html><body>HW</body></html>", someHTML('HW').toString)
15     }
16
17 }
```

Templates (2)

```
@Test
def test2() {

// loading
var pollS = loadPollSystem(URI.createURI("foo1.q"))

// MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
var html = toPolls(pollS.polls)
assertNotNull(html)

// serializing (note: we could type check the HTML
// with Xtext by specifying the grammar for instance)
val fw = new FileWriter("foo1.html")
fw.write(html.toString)
fw.close


}

def toPolls(List<Poll> polls) '''
  <html>
    <body>
      «FOR p : polls»
        «IF p.name != null»
          <h1>«p.name»</h1>
        «ENDIF»
        «FOR q : p.questions»
        <p>
            <h2>«q.text»</h2>
            <ul>
             «FOR o : q.options»
             <li>«o.text»</li>
             «ENDFOR»
            </ul>
        </p>
        «ENDFOR»
      «ENDFOR»
    </body>
  </html>
'''
```







Templates (3)

- You already experiment with web templating engines (JSP, Scala templates in Play!, Symfony templates, etc.)

```
    <h1>Exemple de page JSP</h1>
    <%-- Impression de variables --%>
    <p>Au moment de l'exécution de ce script, nous sommes le <%= date %>.</p>
    <p>Cette page a été affichée <%= nombreVisites %> fois !</p>
  </body>
</html>
```

- Alternatives exist in the modeling world
  - Multiple pre-defined and customizables generators

- Xtend: seamless integration into a general purpose language

Xtend to Java

HelloWorld.xtend | HelloWorld.java

```
1  package fr.inria.k3;
2
3  import org.eclipse.xtext.xbase.lib.InputOutput;
4
5  @SuppressWarnings("all")
6  public class HelloWorld {
7    public static void main(final String[] args) {
8      InputOutput.<String>println("HW");
9    }
10 }
11
```

Xtend to Java (2)

more after

HelloWorld.xtend | HelloWorld.java

```
1  package fr.inria.k3;
2
3  import org.eclipse.xtext.xbase.lib.InputOutput;
4
5  @SuppressWarnings("all")
6  public class HelloWorld {
7    public static void main(final String[] args) {
8      InputOutput.<String>println("HW");
9    }
10 }
11
```

```
package org.eclipse.xtext.xbase.lib;

import com.google.common.annotations.GwtCompatible;

/**
 * Utilities to print information to the console.
 *
 * @author Sven Efftinge - Initial contribution and API
 */
@GwtCompatible public class InputOutput {

    /**
     * Prints a newline to standard out, by delegating directly to <code>System.out.println()</code>
     * @since 2.3
     */
    public static void println() {
        System.out.println();
    }
    /**
     * Prints the given {@code object} to {@link System#out System.out} and terminate the line. Useful to log partial
     * expressions to trap errors, e.g. the following is possible: <code>println(1 + println(2)) + 3</code>
     *
     * @param object
     *            the to-be-printed object
     * @return the printed object.
     */
    public static <T> T println(T object) {
        System.out.println(object);
        return object;
    }
```

Xtend/Xtext

Back to our scenarios

MDE chain

Another DSL

Model-to-Model

Pivot MM

```
PollSystem {
    Poll Quality {
        Question q1 {
            "Value the user experience"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
        Question q2 {
            "Value the layout"
            options {
                A : "It was not easy to locate elements"
                B : "I didn't realize"
                C : "It was easy to locate elements"
            }
        }
    }
    Poll Performance {
        Question q1 {
            "Value the time response"
            options {
                A : "Bad"
                B : "Fair"
                C : "Good"
            }
        }
    }
}
```

UI model

Text-to-Model

Generator

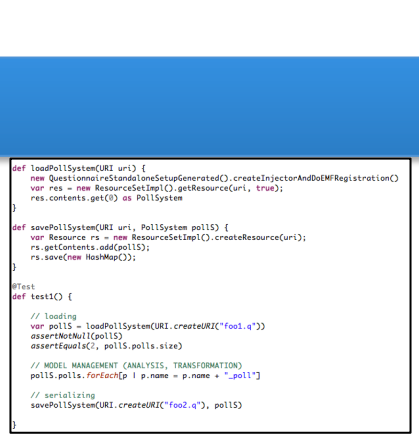
Model-to-Text

(web forms)

Refactoring of Polls

foo1.q

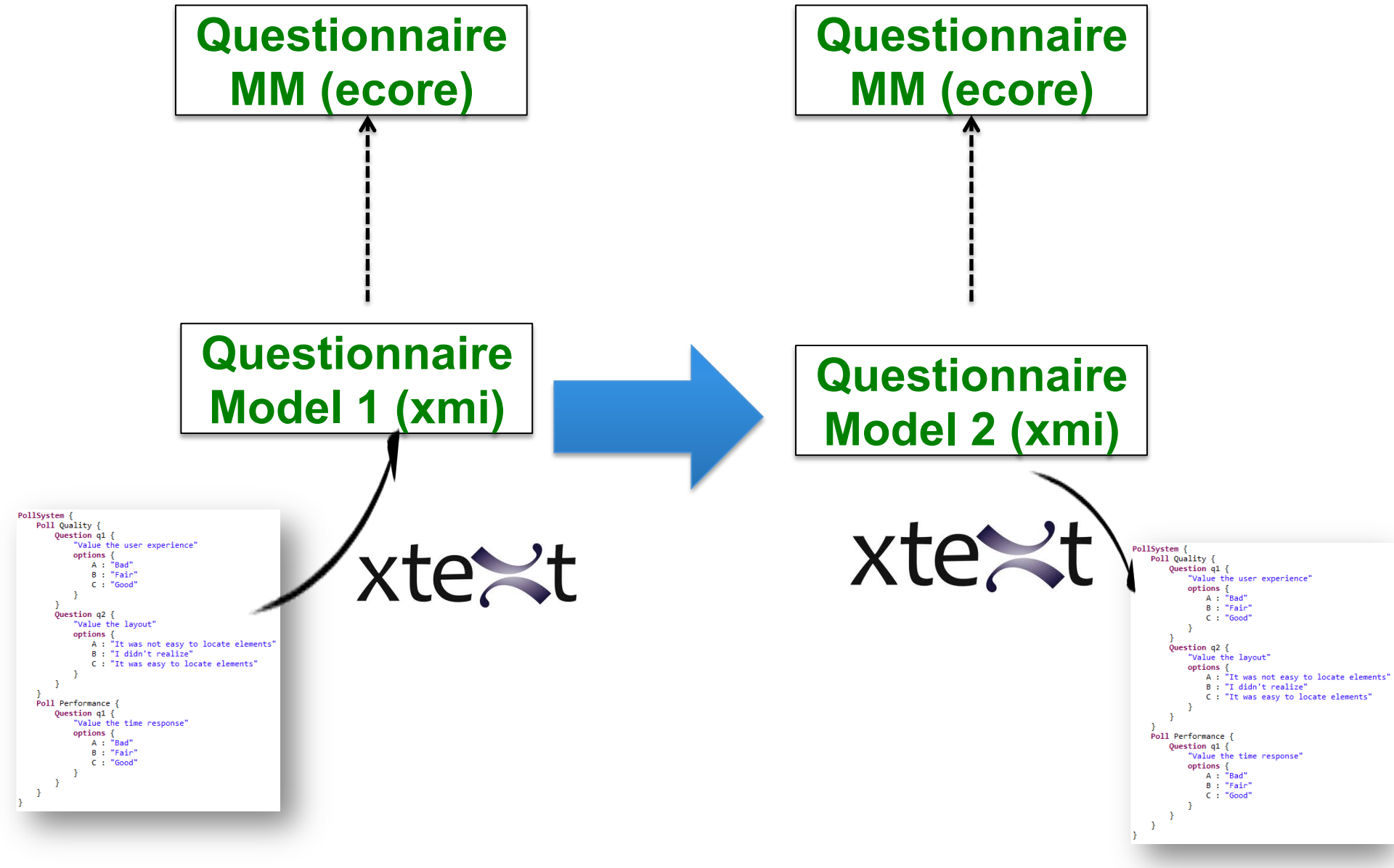
```
PollSystem {

    Poll poll1 {

        Question A {
            "What is A ?"
            options
                    b : "B"
                    c : "C"
                    d : "D"

        }

    }

    Poll poll2 {

        Question D {
            "What is D ?"
            options
                    e : "E"
                    f : "F"

        }

    }

}
```



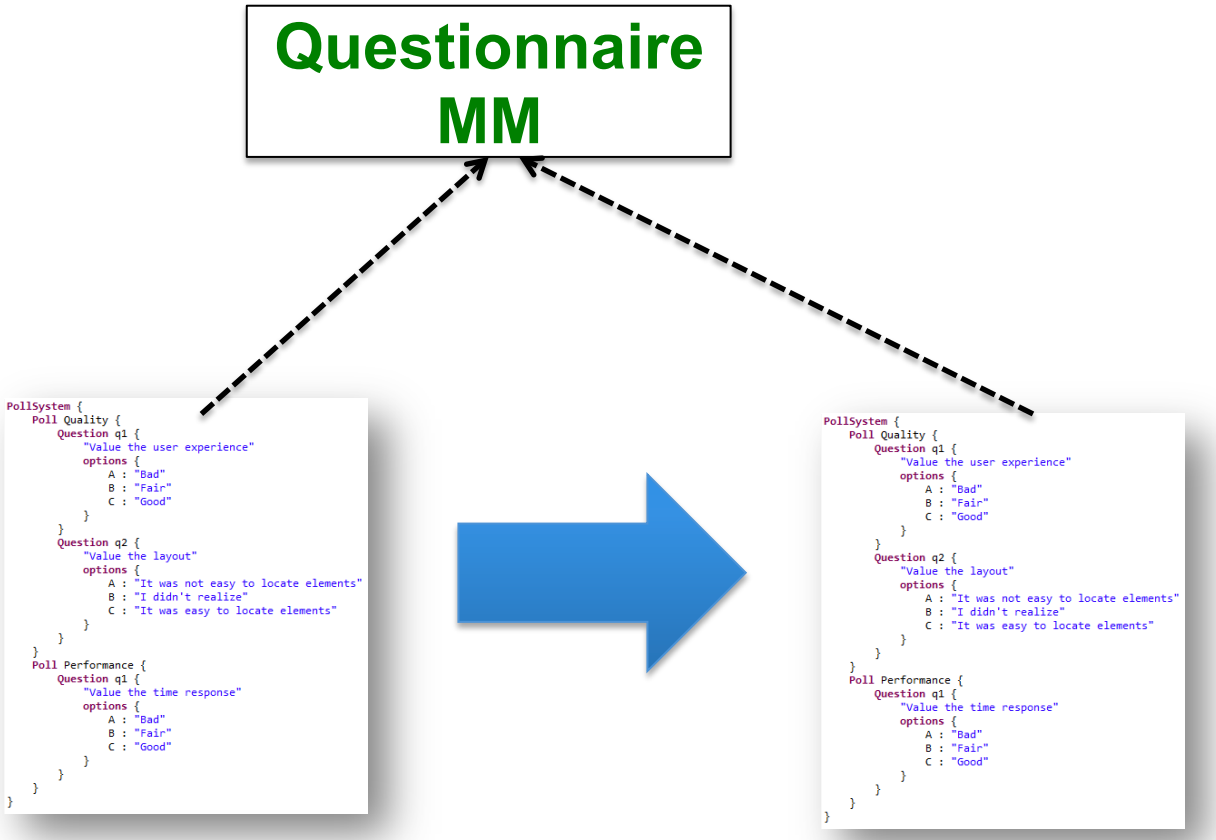
```
def loadPollSystem(URI uri) {
    new QuestionnaireStandaloneSetupGenerated().createInjectorAndDoEMFRegistration()
    var res = new ResourceSetImpl().getResource(uri, true);
    res.contents.get(0) as PollSystem
}

def savePollSystem(URI uri, PollSystem pollS) {
    var Resource rs = new ResourceSetImpl().createResource(uri);
    rs.getContents.add(pollS);
    rs.save(new HashMap());
}

@Test
def test1() {

    // loading
    var pollS = loadPollSystem(URI.createURI("foo1.q"))
    assertNotNull(pollS)
    assertEquals(2, pollS.polls.size)

    // MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
    pollS.polls.forEach[p | p.name = p.name + "_poll"]

    // serializing
    savePollSystem(URI.createURI("foo2.q"), pollS)

}
```

foo1.q | foo2.q

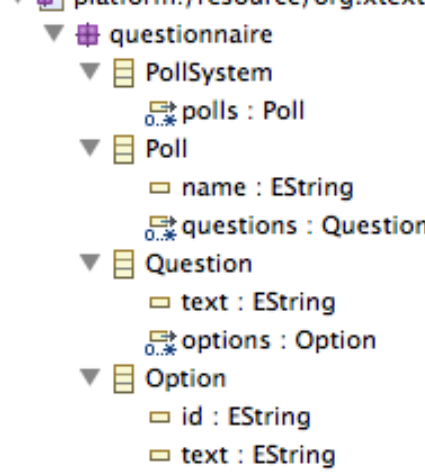
```
PollSystem {

    Poll poll1_poll {

        Question {
            "What is A ?"
            options
                    b : "B"
                    c : "C"
                    d : "D"

        }

    }

    Poll poll2_poll {

        Question {
            "What is D ?"
            options
                    e : "E"
                    f : "F"

        }

    }

}
```


Questionnaire MM (ecore)
Questionnaire MM (ecore)
Questionnaire Model 1 (xmi)
Questionnaire Model 2 (xmi)
xtext
xtext
PollSystem {
Poll Quality {
Question q1 {
"Value the user experience"
options {
A : "Bad"
B : "Fair"
C : "Good"
}
}
Question q2 {
"Value the layout"
options {
A : "It was not easy to locate elements"
B : "I didn't realize"
C : "It was easy to locate elements"
}
}
}
Poll Performance {
Question q1 {
"Value the time response"
options {
A : "Bad"
B : "Fair"
C : "Good"
}
}
}
}
PollSystem {
Poll Quality {
Question q1 {
"Value the user experience"
options {
A : "Bad"
B : "Fair"
C : "Good"
}
}
Question q2 {
"Value the layout"
options {
A : "It was not easy to locate elements"
B : "I didn't realize"
C : "It was easy to locate elements"
}
}
}
Poll Performance {
Question q1 {
"Value the time response"
options {
A : "Bad"
B : "Fair"
C : "Good"
}
}
}
}

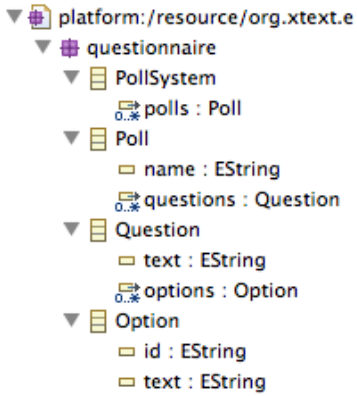
Endogeneous Transformation

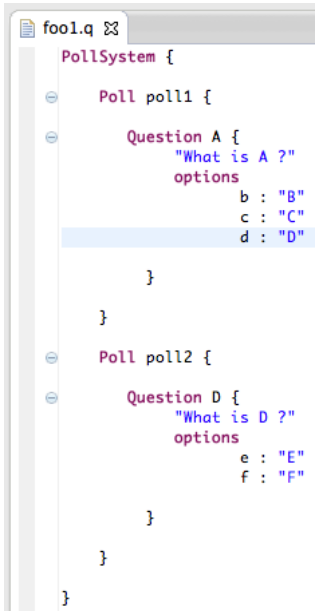


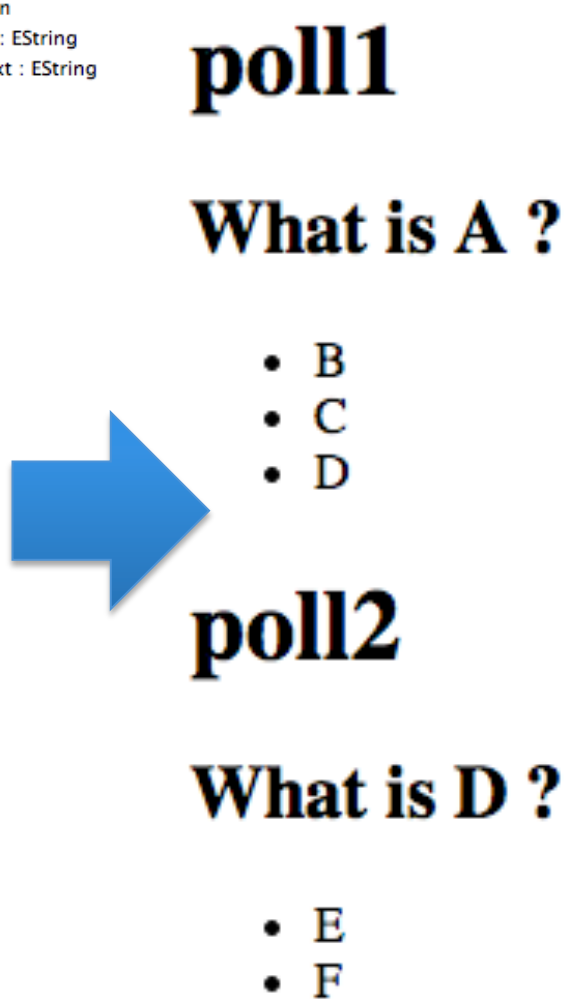
```
def loadPollSystem(URI uri) {
    new QuestionnaireStandaloneSetupGenerated().createInjectorAndDoEMFRegistration()
    var res = new ResourceSetImpl().getResource(uri, true);
    res.contents.get(0) as PollSystem
}

def savePollSystem(URI uri, PollSystem pollS) {
    var Resource rs = new ResourceSetImpl().createResource(uri);
    rs.getContents.add(pollS);
    rs.save(new HashMap());
}

@Test
def test1() {

    // loading
    var pollS = loadPollSystem(URI.createURI("foo1.q"))
    assertNotNull(pollS)
    assertEquals(2, pollS.polls.size)

    // MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
    pollS.polls.forEach[p | p.name = p.name + "_poll"]

    // serializing
    savePollSystem(URI.createURI("foo2.q"), pollS)

}
```



```
@Test
def test2() {

// loading
var pollS = loadPollSystem(URI.createURI("foo1.q"))

// MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
var html = toPolls(pollS.polls)
assertNotNull(html)

// serializing (note: we could type check the HTML
// with Xtext by specifying the grammar for instance)
val fw = new FileWriter("foo1.html")
fw.write(html.toString)
fw.close


}

def toPolls(List<Poll> polls) '''
  <html>
    <body>
      «FOR p : polls»
        «IF p.name != null»
          <h1>«p.name»</h1>
        «ENDIF»
        «FOR q : p.questions»
        <p>
            <h2>«q.text»</h2>
            <ul>
             «FOR o : q.options»
             <li>«o.text»</li>
             «ENDFOR»
            </ul>
        </p>
        «ENDFOR»
      «ENDFOR»
    </body>
  </html>
'''
```







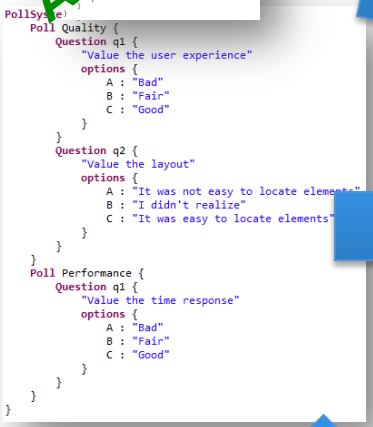
Lab Sessions

Overview

MDE chain

TP 3

Another DSL



Model-to-Model

TP 4

Pivot MM

TP 3

UI model

Text-to-Model

TP 2

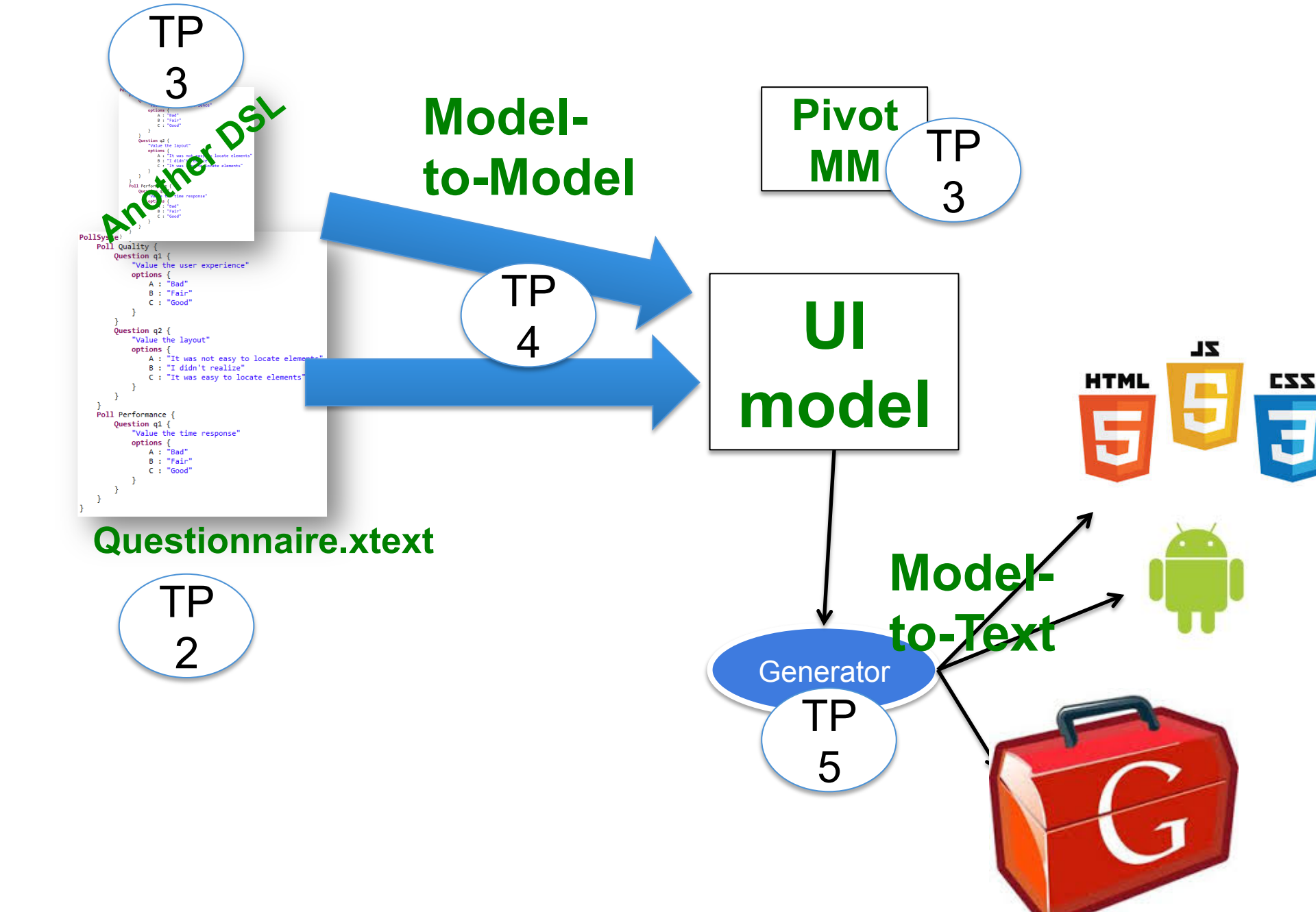
Generator

TP 5

Model-to-Text

HTML JS CSS

(web forms)


TP 3
Another DSL
PollSystem {
Poll Quality {
Question q1 {
"Value the user experience"
options {
A : "Bad"
B : "Fair"
C : "Good"
}
}
Question q2 {
"Value the layout"
options {
A : "It was not easy to locate elements"
B : "I didn't realize"
C : "It was easy to locate elements"
}
}
}
Poll Performance {
Question q1 {
"Value the time response"
options {
A : "Bad"
B : "Fair"
C : "Good"
}
}
}
}
Questionnaire.xtext
TP 2
Model-to-Model
TP 4
Pivot MM
TP 3
UI model
HTML
JS
CSS
Model-to-Text
Generator
TP 5

Xtend

Advanced features (active annotation)
Model transformation in depth
MDE enables Xtend

http://www.eclipse.org/xtend/documentation.html
http://jnario.org/org/jnario/jnario/documentation/20FactsAboutXtendSpec.html
http://blog.efftinge.de/2012/12/java-8-vs-xtend.html
http://eclipsesource.com/blogs/tutorials/emf-tutorial/

JSON Questionnaire

JSON ?

Interoperability with the Xtext MM ?