

Model Management in Xtend (first part)

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@acherm

Maître de Conférences

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Material

**[https://github.com/acherm/
teaching-MDE1920-MIAGE](https://github.com/acherm/teaching-MDE1920-MIAGE)**

Plan

- Model Management in a nutshell
 - Loading, serializing, transforming models
- Xtend
 - Java 10, cheatsheet
 - Advanced features: extension methods, active annotations, template expressions
 - Xtend: behind 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



Generator
~ composition of
video sequences

**video
variants**





Generator
~ composition of
video sequences

**video
variants**





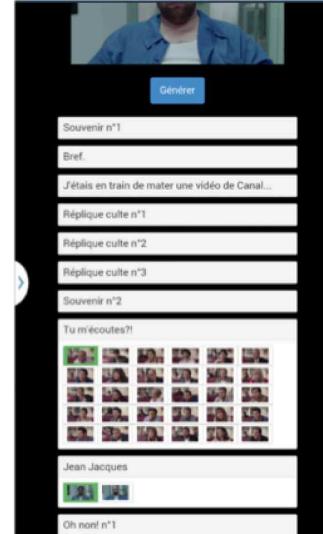
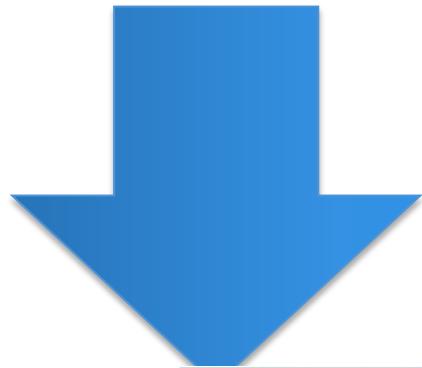
foo1.videogen ✎

```

mandatory videoseq v1 "https://www.youtube.com/watch?v=PjNi1uYhV5w"
optional videoseq v2 "v2/folder/v2.mp4"
alternatives v3 {
    videoseq v31 "v3/seq1.mp4"
    videoseq v32 "v3/seq1.mp4"
    videoseq v33 "v3/seq1.mp4"
}

alternatives v4 {
    videoseq v41 "v4/seq1.mp4"
    videoseq v42 "v4/seq1.mp4"
}
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"

```



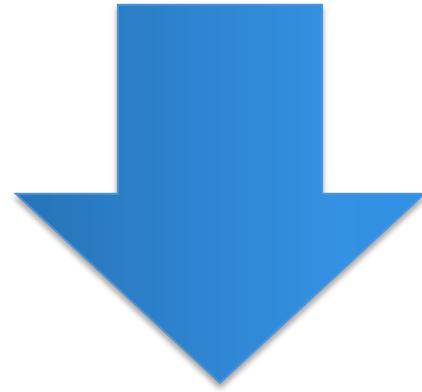
- ## Website/online
- Random generation
 - Configurator
 - Game
 - ...



```
foo1.videogen ✘

mandatory videotseq v1 "https://www.youtube.com/watch?v=PjNi1uYhV5w"
optional videotseq v2 "v2folder/v2.mp4"
alternatives v3 {
    videotseq v31 "v3/seq1.mp4"
    videotseq v32 "v3/seq1.mp4"
    videotseq v33 "v3/seq1.mp4"
}

alternatives v4 {
    videotseq v41 "v4/seq1.mp4"
    videotseq v42 "v4/seq1.mp4"
}
mandatory videotseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```



 FFmpeg

foo1.videogen ✘

```
mandatory videoseq v1 "https://www.youtube.com/watch?v=PJNi1uYhV5w"
optional videoseq v2 "v2folder/v2.mp4"
alternatives v3 {
    videoseq v31 "v3/seq1.mp4"
    videoseq v32 "v3/seq1.mp4"
    videoseq v33 "v3/seq1.mp4"
}

alternatives v4 {
    videoseq v41 "v4/seq1.mp4"
    videoseq v42 "v4/seq1.mp4"
}
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```

#1 How to design,
create, and support
dedicated languages
(DSLs)?

#2 How to
transform
models/
programs?

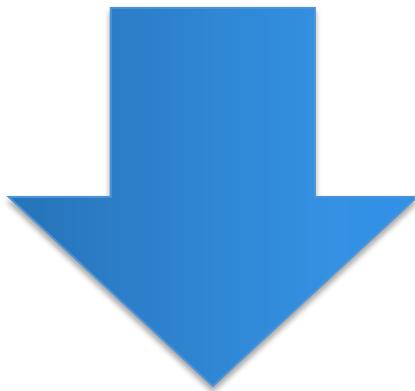


#3 How to manage
variability/variants?

#4 How do
frameworks
internally work?

```
foo1.videogen
```

```
mandatory videoseq v1 "https://www.youtube.com/watch?v=PjNi1uYhV5w"  
optional videoseq v2 "v2Folder/v2.mp4"  
alternatives v3 {  
    videoseq v31 "v3/seq1.mp4"  
    videoseq v32 "v3/seq1.mp4"  
    videoseq v33 "v3/seq1.mp4"  
}  
  
alternatives v4 {  
    videoseq v41 "v4/seq1.mp4"  
    videoseq v42 "v4/seq1.mp4"  
}  
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```



model-to-text

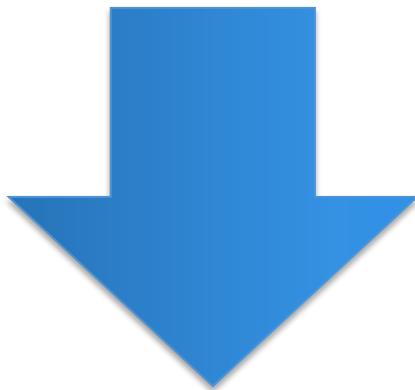
```
# this is a comment  
file 'v3/seq1.avi'  
file '/path/to/video2.avi'  
file '/path/to/video3.avi'
```

 FFmpeg

foo1.videogen

```
mandatory videoseq v1 "https://www.youtube.com/watch?v=PjNi1uYhV5w"
optional videoseq v2 "v2Folder/v2.mp4"
alternatives v3 {
    videoseq v31 "v3/seq1.mp4"
    videoseq v32 "v3/seq1.mp4"
    videoseq v33 "v3/seq1.mp4"
}

alternatives v4 {
    videoseq v41 "v4/seq1.mp4"
    videoseq v42 "v4/seq1.mp4"
}
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```



model-to-text

.m3u

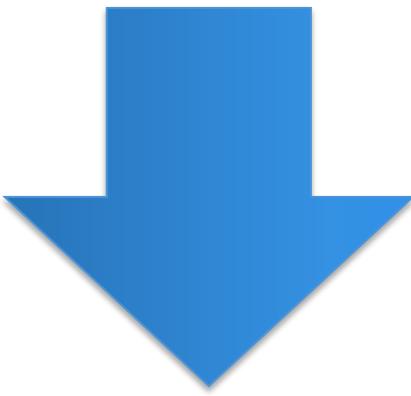
```
v3/seq1.avi
/path/to/video2.avi
/path/to/video3.avi
```



foo1.videogen

```
mandatory videoseq v1 "https://www.youtube.com/watch?v=PjNi1uYhV5w"
optional videoseq v2 "v2Folder/v2.mp4"
alternatives v3 {
    videoseq v31 "v3/seq1.mp4"
    videoseq v32 "v3/seq1.mp4"
    videoseq v33 "v3/seq1.mp4"
}

alternatives v4 {
    videoseq v41 "v4/seq1.mp4"
    videoseq v42 "v4/seq1.mp4"
}
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```



model-to-text

.m3u
(extended)

```
#EXTM3U
#EXT-X-DISCONTINUITY
#EXTINF:3
resources/videos/vp0-logo/logo_start.ts
#EXT-X-DISCONTINUITY
#EXTINF:12
resources/videos/vp1-QR/QR05_1.ts
#EXT-X-DISCONTINUITY
#EXTINF:2
resources/videos/vp2-intro-fluide-glacial/
EtPendantCeTempsLaEn1975_processed.ts
```

flowplayer flash

```
foo1.videogen &gt;
mandatory videoseq v1 "https://www.youtube.com/watch?v=PjNi1uYhV5w"
optional videoseq v2 "v2folder/v2.mp4"
alternatives v3 {
    videoseq v31 "v3/seq1.mp4"
    videoseq v32 "v3/seq1.mp4"
    videoseq v33 "v3/seq1.mp4"
}

alternatives v4 {
    videoseq v41 "v4/seq1.mp4"
    videoseq v42 "v4/seq1.mp4"
}
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```

model-to-model

**playlist
metamodel**

playlist model

model-to-text

flowplayer **flash**

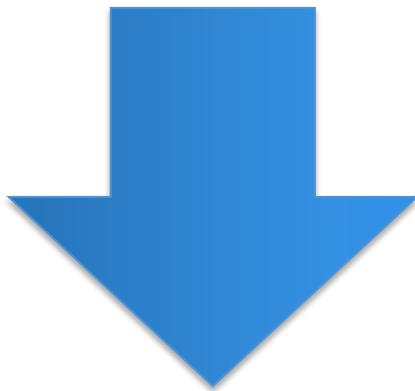


FFmpeg

foo1.videogen

```
mandatory videoseq v1 "https://www.youtube.com/watch?v=PjNi1uYhV5w"
optional videoseq v2 "v2Folder/v2.mp4"
alternatives v3 {
    videoseq v31 "v3/seq1.mp4"
    videoseq v32 "v3/seq1.mp4"
    videoseq v33 "v3/seq1.mp4"
}

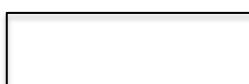
alternatives v4 {
    videoseq v41 "v4/seq1.mp4"
    videoseq v42 "v4/seq1.mp4"
}
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```



model-to-*



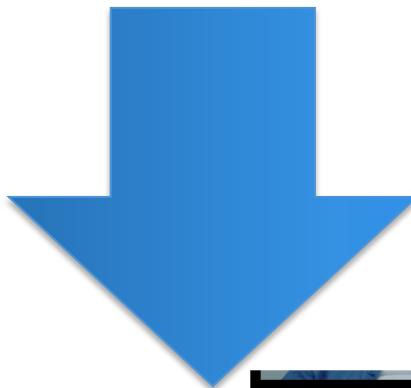
Thumbnails
(vignettes) of
each video
sequence
(e.g., PGN
format)



foo1.videogen

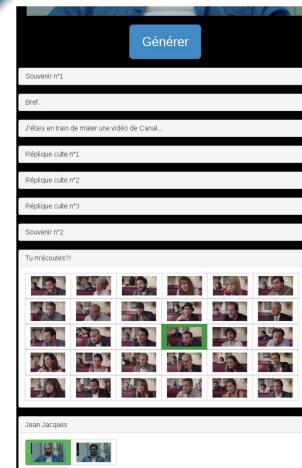
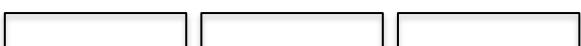
```
mandatory videoseq v1 "https://www.youtube.com/watch?v=PjNi1uYhV5w"
optional videoseq v2 "v2Folder/v2.mp4"
alternatives v3 {
    videoseq v31 "v3/seq1.mp4"
    videoseq v32 "v3/seq1.mp4"
    videoseq v33 "v3/seq1.mp4"
}

alternatives v4 {
    videoseq v41 "v4/seq1.mp4"
    videoseq v42 "v4/seq1.mp4"
}
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```



model-to-*
FFmpeg

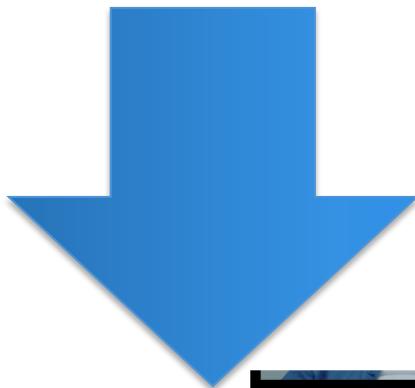
Thumbnails (vignettes) of each video sequence (e.g., PGN format)



foo1.videogen

```
mandatory videoseq v1 "https://www.youtube.com/watch?v=PjNi1uYhV5w"
optional videoseq v2 "v2Folder/v2.mp4"
alternatives v3 {
    videoseq v31 "v3/seq1.mp4"
    videoseq v32 "v3/seq1.mp4"
    videoseq v33 "v3/seq1.mp4"
}

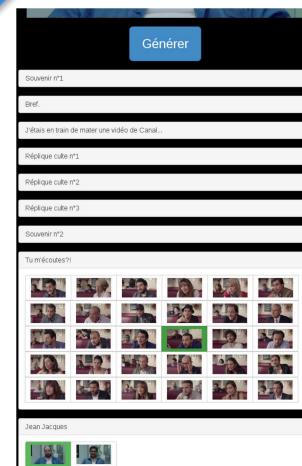
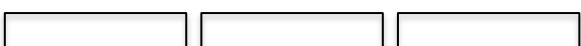
alternatives v4 {
    videoseq v41 "v4/seq1.mp4"
    videoseq v42 "v4/seq1.mp4"
}
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```



model-to-*



Thumbnails (vignettes) of each video sequence (e.g., PGN format)

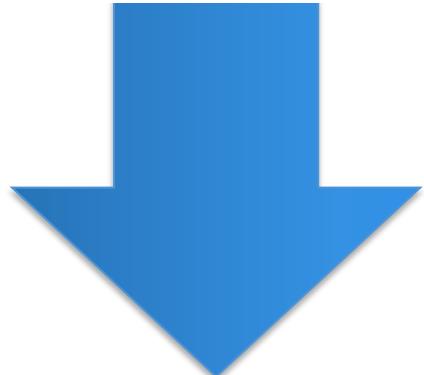


JS



foo1.videogen

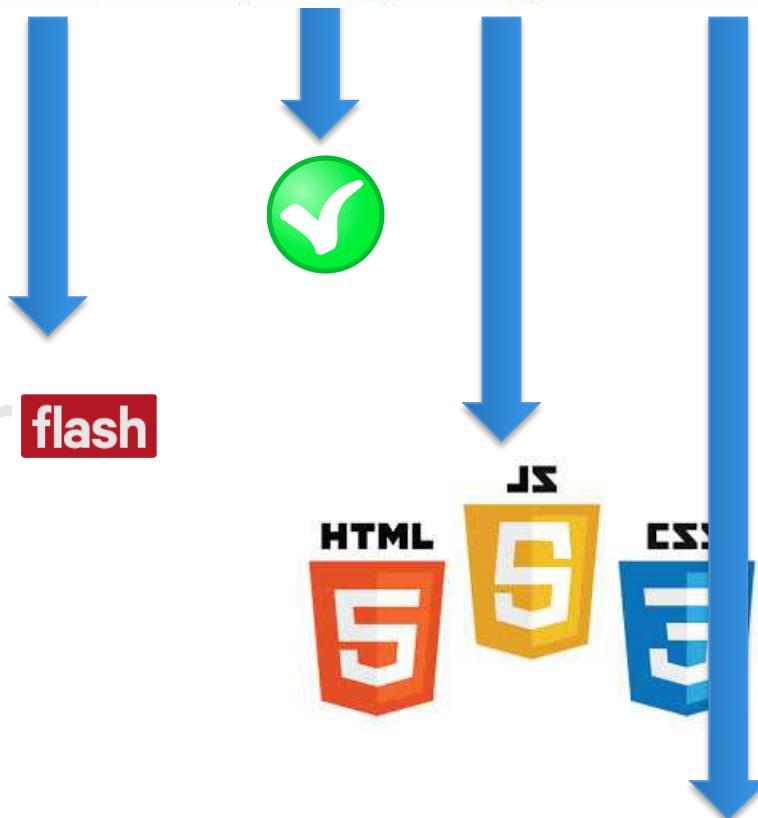
```
VideoGen {  
    mandatory videoseq v1 "V1/v1.mp4"  
    optional videoseq v2 "v2folder/v2.mp4" {  
        probability 25  
    }  
    alternatives v3 {  
        videoseq v31 "v3/seq1.mp4" {  
            duration 12  
            probability 25  
            description "a"  
        }  
        videoseq v31 "v3/seq2.mp4"  
        videoseq v32 "v3/seq3.mp4"  
    }  
    alternatives v4 {  
        videoseq v41 "v4/seq1.mp4"  
        videoseq v42 "v4/seq2.mp4"  
    }  
    mandatory videoseq v5 "v5.mp4"  
    optional videoseq v8 "v8.gvi"  
    alternatives v9 {  
        videoseq v81 "V81.gvi"  
    }  
}
```



foo1.videoogen

```
mandatory videooseq v1 "https://www.youtube.com/watch?v=PJNi1uYhV5w"
optional videooseq v2 "v2Folder/v2.mp4"
alternatives v3 {
    videooseq v31 "v3/seq1.mp4"
    videooseq v32 "v3/seq1.mp4"
    videooseq v33 "v3/seq1.mp4"
}

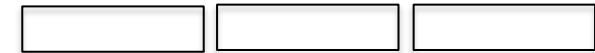
alternatives v4 {
    videooseq v41 "v4/seq1.mp4"
    videooseq v42 "v4/seq1.mp4"
}
mandatory videooseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```



flowplayer **flash**



 FFmpeg



18, 167, 899



foo1.videoogen

```
mandatory videooseq v1 "https://www.youtube.com/watch?v=PJNi1uYhV5w"
optional videooseq v2 "v2folder/v2.mp4"
alternatives v3 {
    videooseq v31 "v3/seq1.mp4"
    videooseq v32 "v3/seq1.mp4"
    videooseq v33 "v3/seq1.mp4"
}

alternatives v4 {
    videooseq v41 "v4/seq1.mp4"
    videooseq v42 "v4/seq1.mp4"
}
mandatory videooseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```



Website/online

- Random generation
- Configurator
- Game
- ...



foo1.videogen

```
mandatory videoseq v1 "https://www.youtube.com/watch?v=PJNi1uYhV5w"
optional videoseq v2 "v2folder/v2.mp4"
@alternatives v3 {
    videoseq v31 "v3/seq1.mp4"
    videoseq v32 "v3/seq1.mp4"
    videoseq v33 "v3/seq1.mp4"
}

@alternatives v4 {
    videoseq v41 "v4/seq1.mp4"
    videoseq v42 "v4/seq1.mp4"
}
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```

Feature model: another model for modeling “features” of your Web site (eg ability to save the video; mode=generation with frequencies)



Website/online

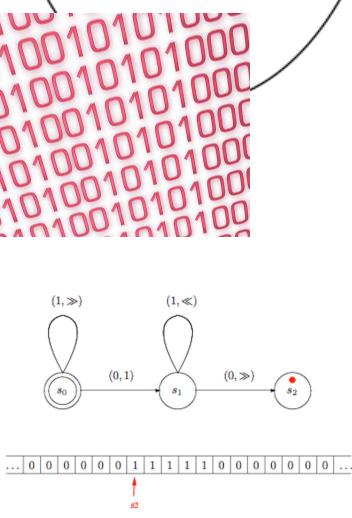
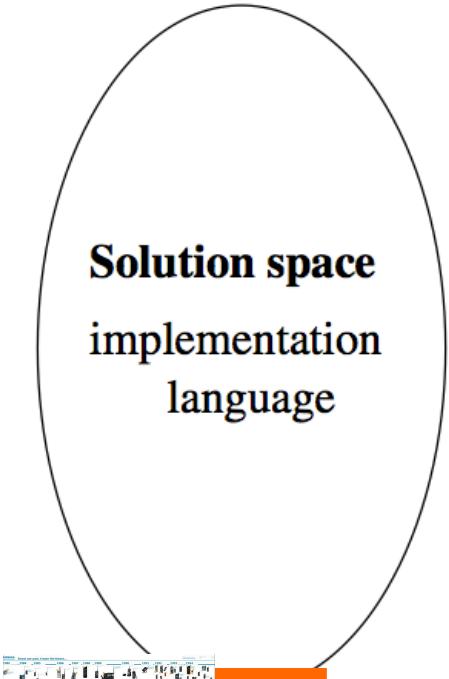
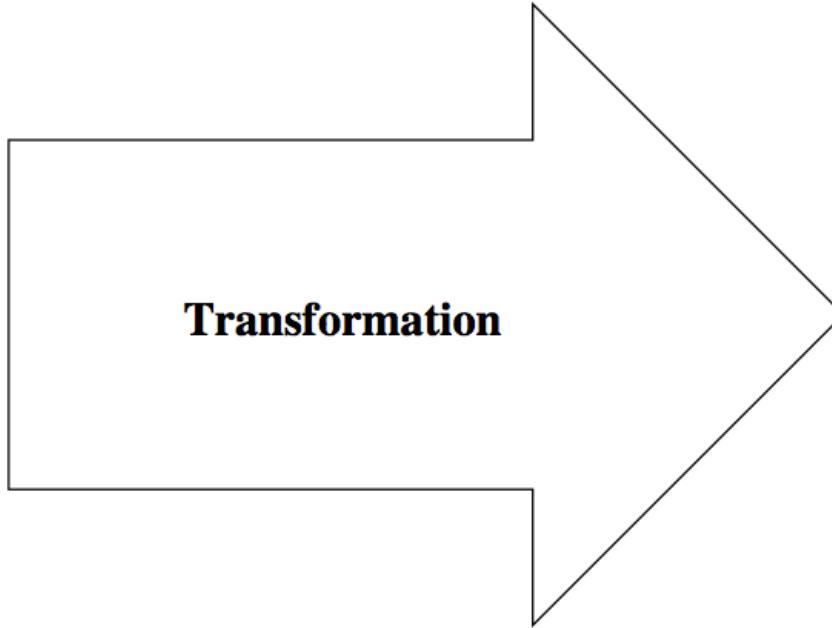
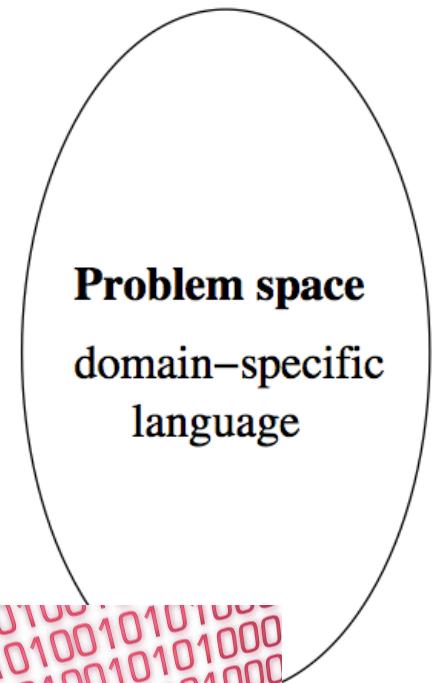
- Random generation
- Configurator
- Game
- ...

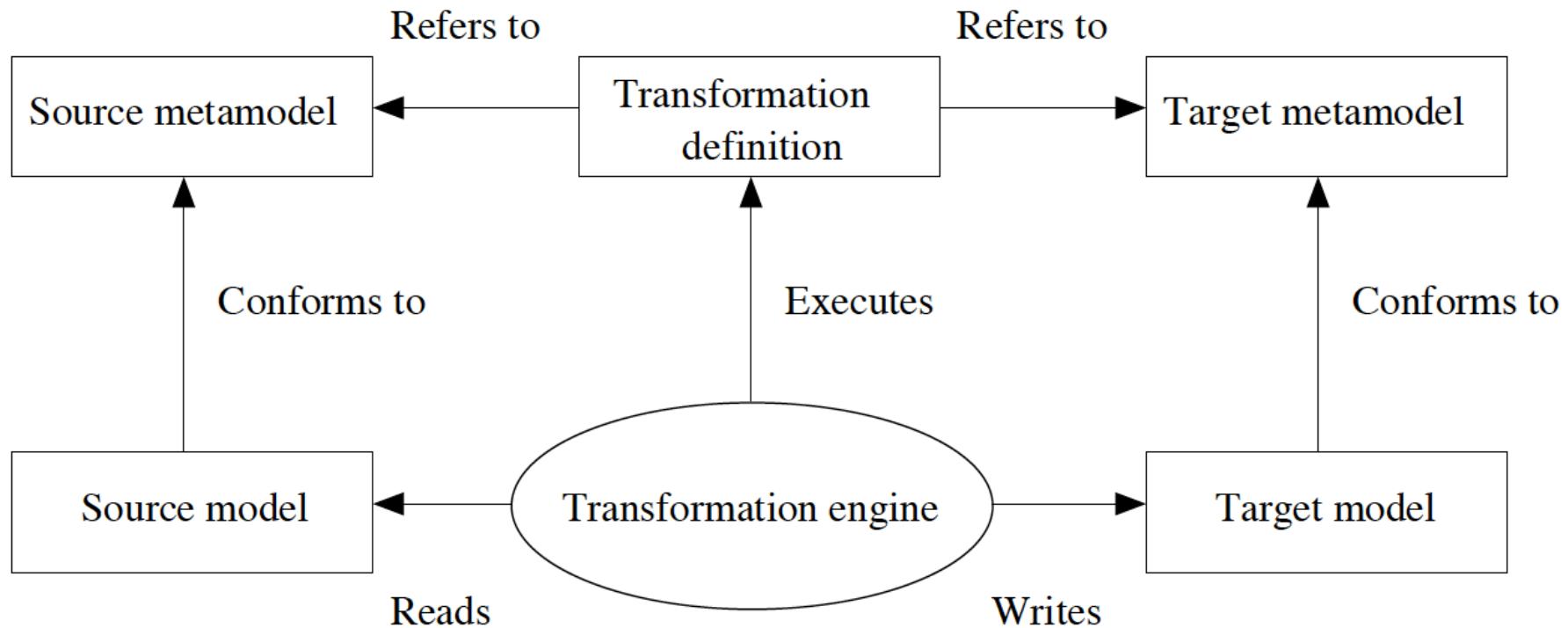
Model Transformations

Taxonomy + Examples

Abstraction Gap

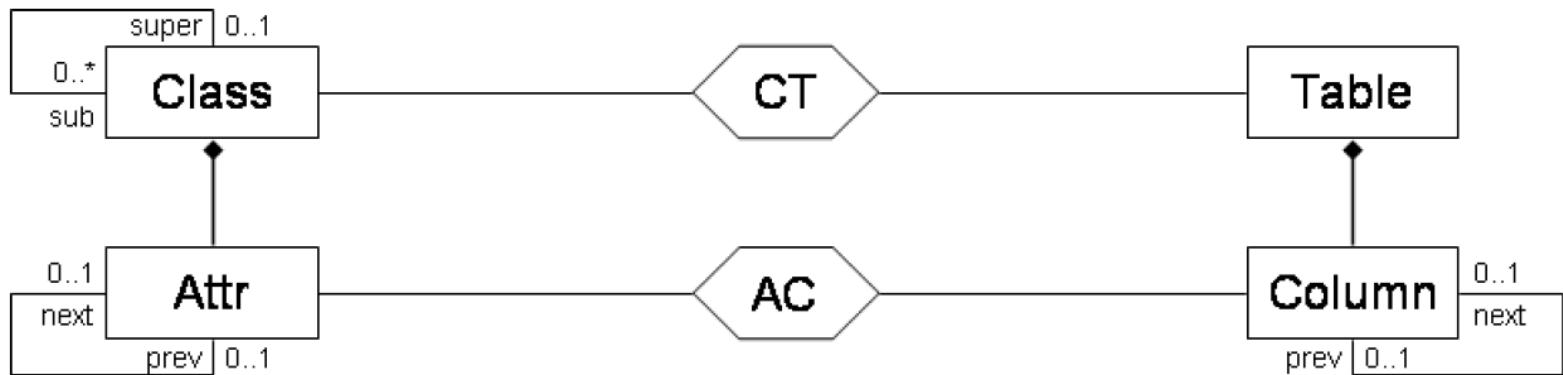
Transformation is the key



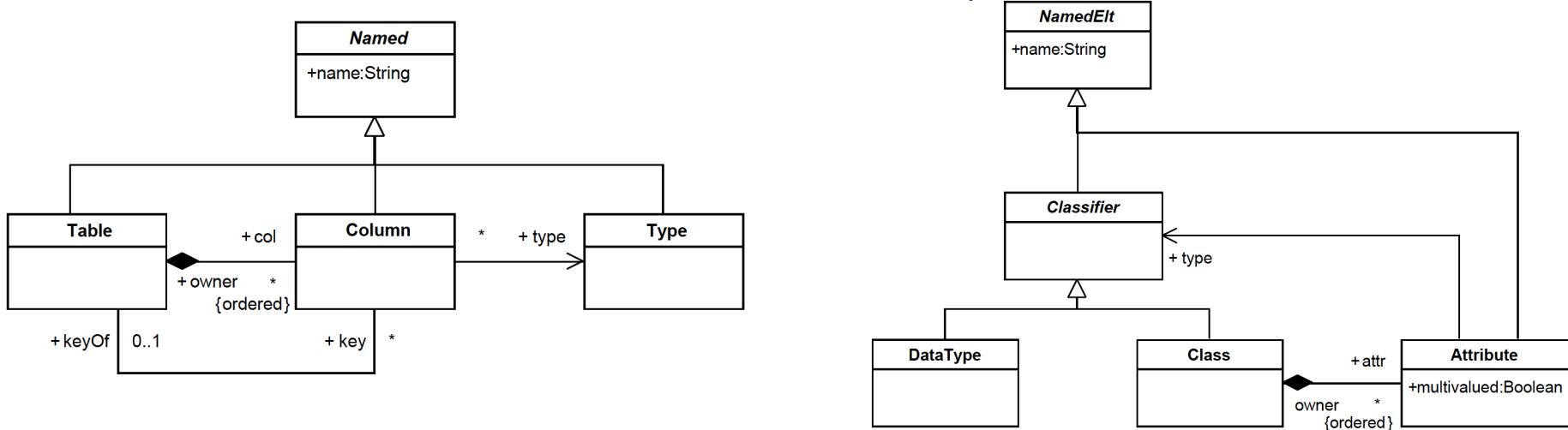


Andy Schürr, Felix Klar “15 Years of Triple Graph Grammars.” ICGT 2008

(declarative; bi-directionnal; model-to-model)



ATL (<http://www.eclipse.org/atl/atlTransformations/>)



```
rule Class2Table {
    from           -- source pattern
        c : Class!Class
    to             -- target pattern
        t : Relational!Table
    }
```

Feature-Based Survey of Model Transformation Approaches

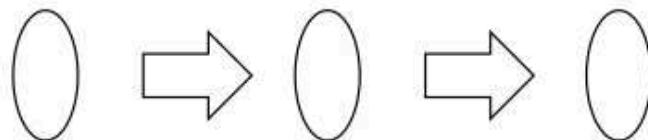
Krzysztof Czarnecki
University of Waterloo
Waterloo, Canada

Simon Helsen
SAP AG
Walldorf, Germany

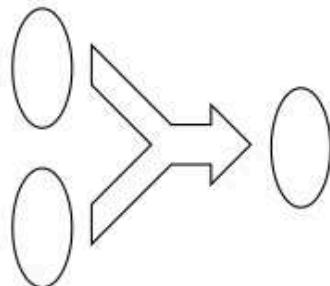
March 15, 2006

Overview of Generative Software Development

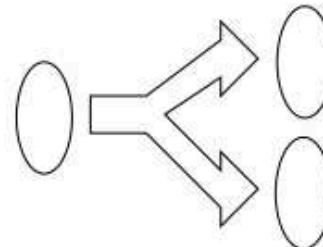
Krzysztof Czarnecki



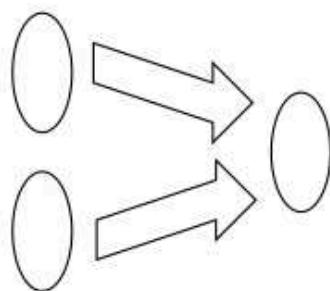
a. Chaining of mappings



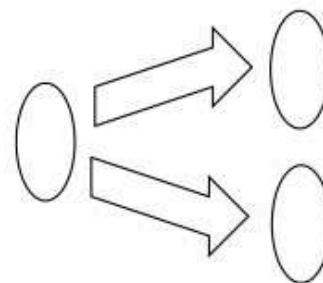
b. Multiple problem spaces



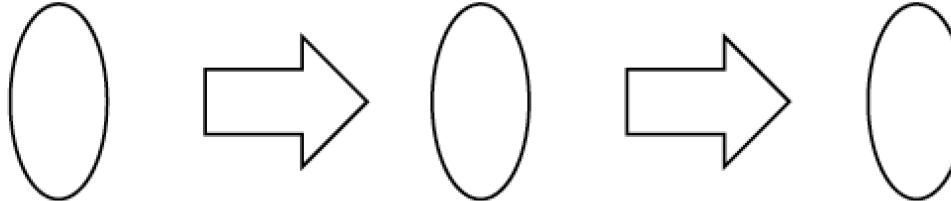
c. Multiple solution spaces



d. Alternative problem spaces e. Alternative solution spaces



One step/stage transformation hardly the case



a. Chaining of mappings

flowplayer flash

```
foo1.videogen ✎
mandatory videoseq v1 "https://www.youtube.com/watch?v=PJNi1uYhV5w"
optional videoseq v2 "v2Folder/v2.mp4"
alternatives v3 {
    videoseq v31 "v3/seq1.mp4"
    videoseq v32 "v3/seq1.mp4"
    videoseq v33 "v3/seq1.mp4"
}

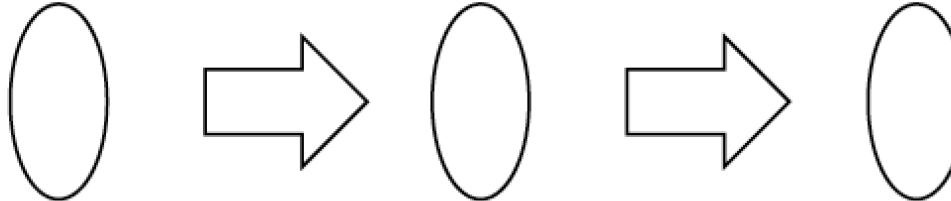
alternatives v4 {
    videoseq v41 "v4/seq1.mp4"
    videoseq v42 "v4/seq1.mp4"
}
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```



```
#EXTM3U
#EXT-X-DISCONTINUITY
#EXTINF:3
resources/videos/vp0-logo/logo_start.ts
#EXT-X-DISCONTINUITY
#EXTINF:12
resources/videos/vp1-QR/QR05_1.ts
#EXT-X-DISCONTINUITY
#EXTINF:2
resources/videos/vp2-intro-fluide-glacial/
EtPendantCeTempsLaEn1975_processed.ts
```

.m3u (extended)

One step/stage transformation hardly the case



a. Chaining of mappings

flowplayer flash

```
foo1.videogen <input>
mandatory videoseq v1 "https://www.youtube.com/watch?v=PJNi1uYhV5w"
optional videoseq v2 "v2Folder/v2.mp4"
alternatives v3 {
    videoseq v31 "v3/seq1.mp4"
    videoseq v32 "v3/seq1.mp4"
    videoseq v33 "v3/seq1.mp4"
}

alternatives v4 {
    videoseq v41 "v4/seq1.mp4"
    videoseq v42 "v4/seq1.mp4"
}
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```



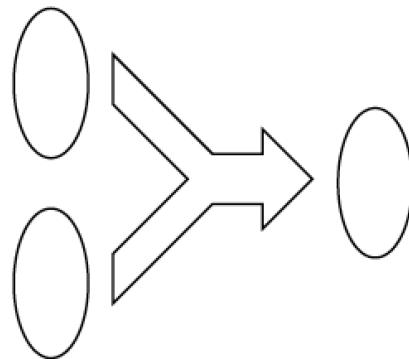
Playlist
model

```
#EXTM3U
#EXT-X-DISCONTINUITY
#EXTINF:3
resources/videos/vp0-logo/logo_start.ts
#EXT-X-DISCONTINUITY
#EXTINF:12
resources/videos/vp1-QR/QR05_1.ts
#EXT-X-DISCONTINUITY
#EXTINF:2
resources/videos/vp2-intro-fluide-glacial/
EtPendantCeTempsLaEn1975_processed.ts
```

.m3u (extended)

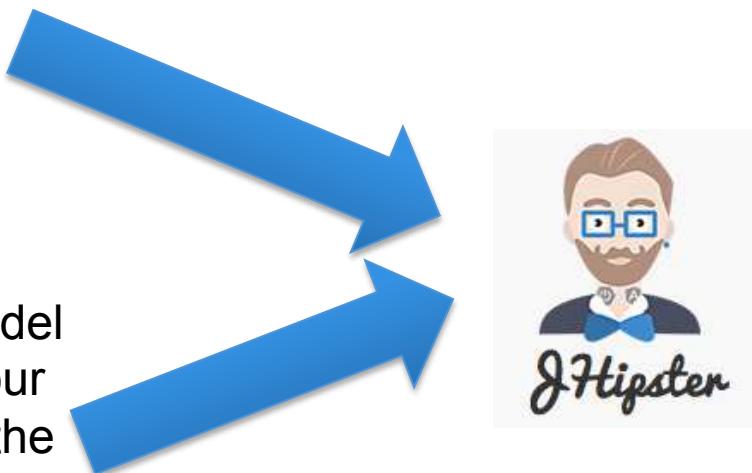
Problem space

Combination of expertises/aspects/DSLs



b. *Multiple problem spaces*

```
foo1.videogen <input>
mandatory videoseq v1 "https://www.youtube.com/watch?v=PJNi1uYhV5w"
optional videoseq v2 "v2folder/v2.mp4"
alternatives v3 {
    videoseq v31 "v3/seq1.mp4"
    videoseq v32 "v3/seq1.mp4"
    videoseq v33 "v3/seq1.mp4"
}
alternatives v4 {
    videoseq v41 "v4/seq1.mp4"
    videoseq v42 "v4/seq1.mp4"
}
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```

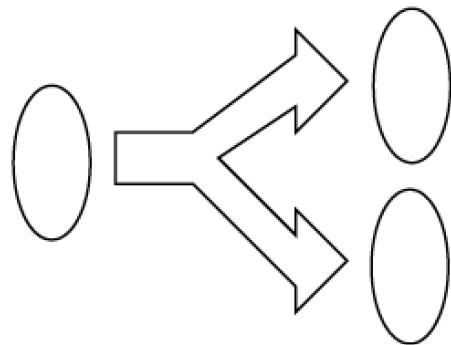


Feature model: another model for modeling “features” of your Web site (eg ability to save the video; mode=generation with frequencies)

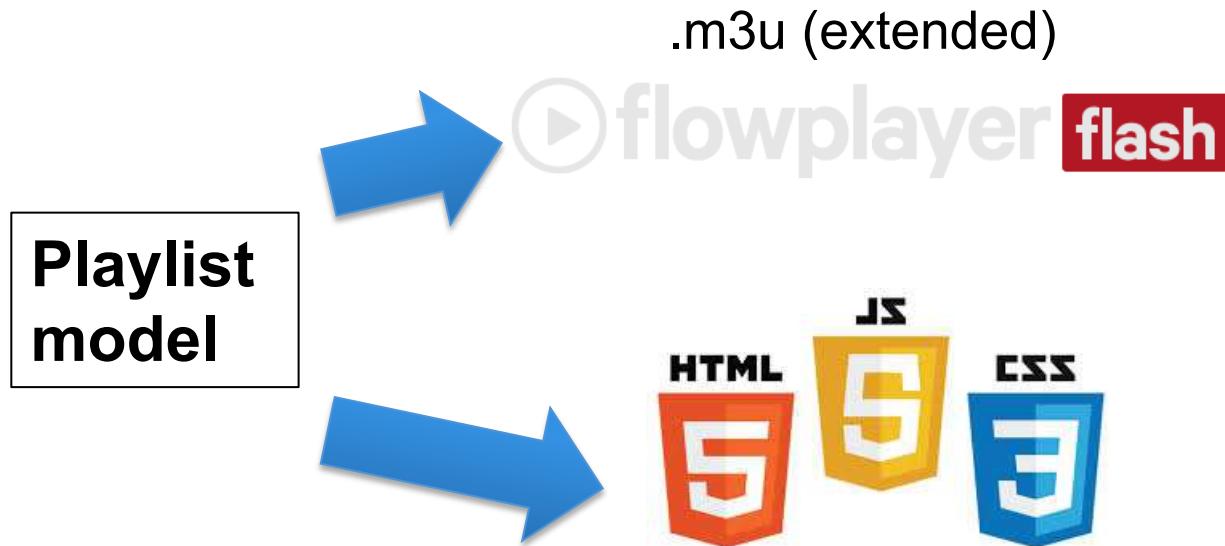


Solution space

Different targets (e.g., technological platforms)

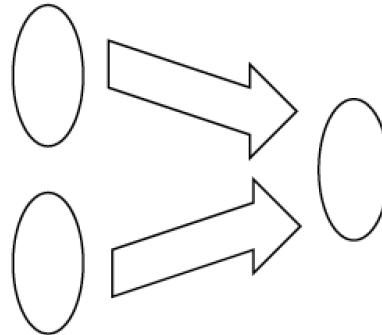


c. *Multiple solution spaces*



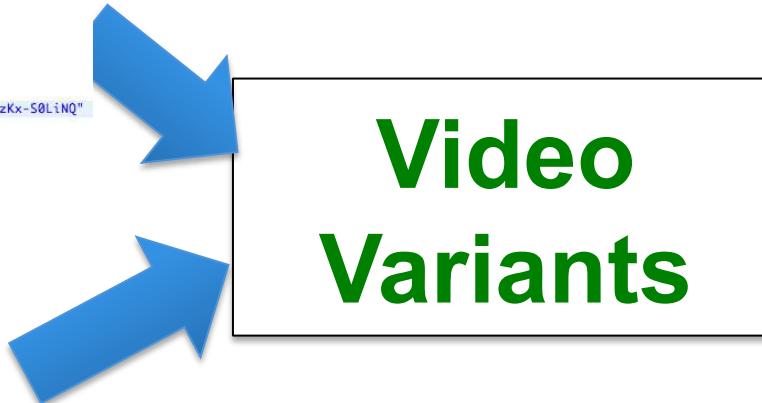
Problem space

e.g., different concrete syntaxes



d. Alternative problem spaces

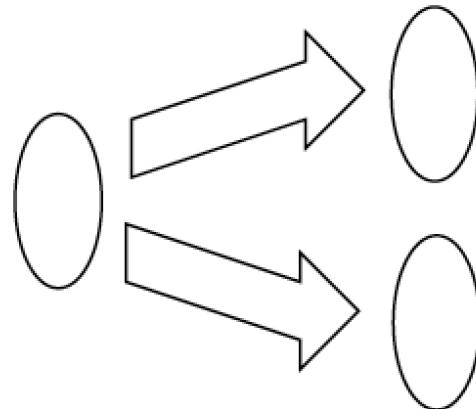
```
foo1.videogen ✘
mandatory videoseq v1 "https://www.youtube.com/watch?v=PJNi1uYhV5w"
optional videoseq v2 "v2folder/v2.mp4"
alternatives v3 {
    videoseq v31 "v3/seq1.mp4"
    videoseq v32 "v3/seq1.mp4"
    videoseq v33 "v3/seq1.mp4"
}
alternatives v4 {
    videoseq v41 "v4/seq1.mp4"
    videoseq v42 "v4/seq1.mp4"
}
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```



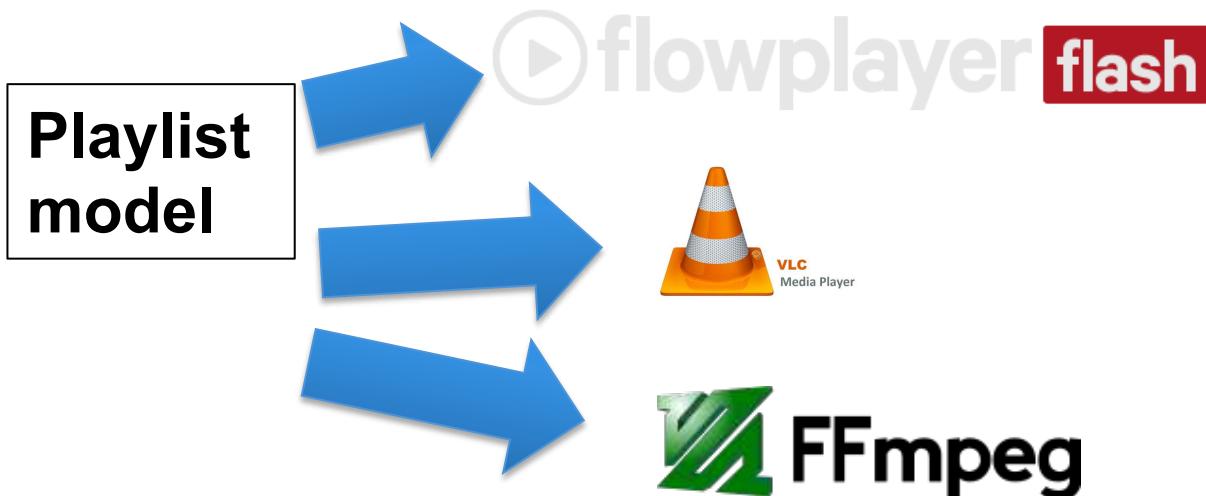
Feature Model
(see next courses)

Solution space

Different targets (e.g., technological platforms)



e. Alternative solution spaces



Model Transformation: Taxonomy

	<p>PIM → PIM PSM → PSM</p> <p><i>Horizontale</i></p> <p><i>Verticale</i></p>	
<p>Transformation endogène</p>	<p>Restructuration Normalisation intégration de patrons</p>	<p>Raffinement</p>
<p>Transformation exogène</p>	<p>Migration de logiciel Fusion de modèles</p>	<p>PIM vers PSM Rétro-conception</p>

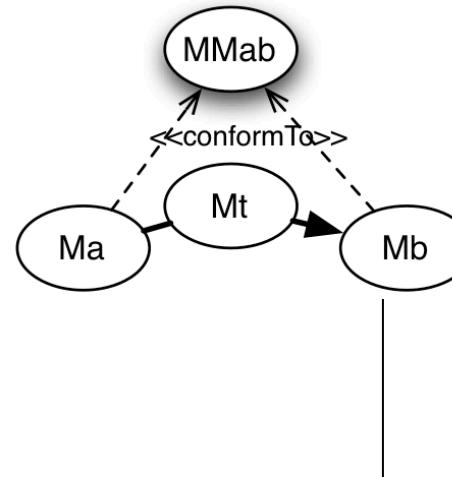
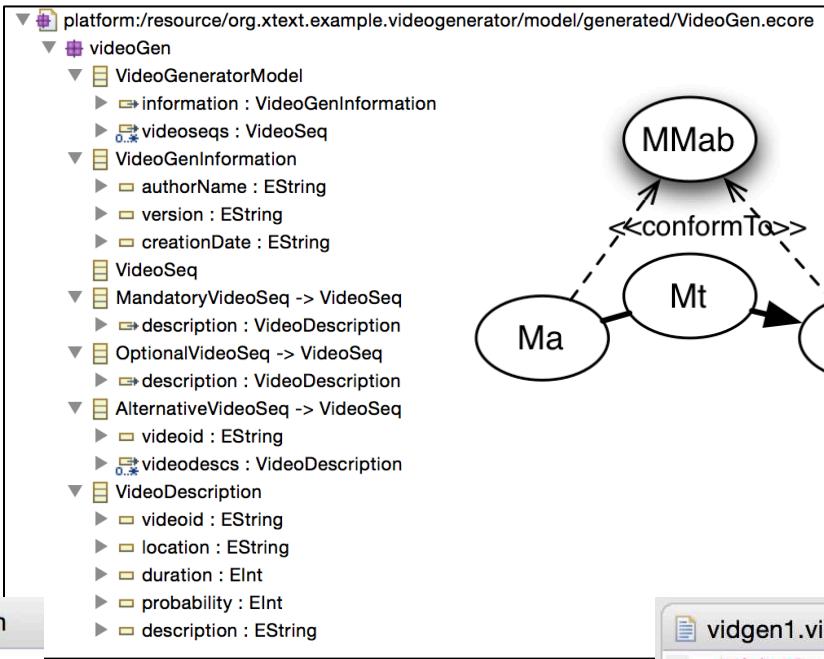
Endogeneous Transformation

```
vidgen1.videogen  vidgen1-bis.videogen
VideoGen {

    mandatory videoseq "V1/v1.mp4"
    optional videoseq "v2folder/v2.mp4" {
        probability 25
    }
    alternatives vid3 {
        videoseq "v3/seq1.mp4"
        videoseq vid31 "v3/seq2.mp4"
        videoseq vid32 "v3/seq3.mp4"
    }

    alternatives vid4 {
        videoseq vid41 "v4/seq1.mp4"
        videoseq vid42 "v4/seq2.mp4"
    }
    mandatory videoseq vid5 "v5.mp4"

    optional videoseq vid8 "v8.avi"
    alternatives vid9 {
        videoseq vid81 "V81.avi"
    }
}
```



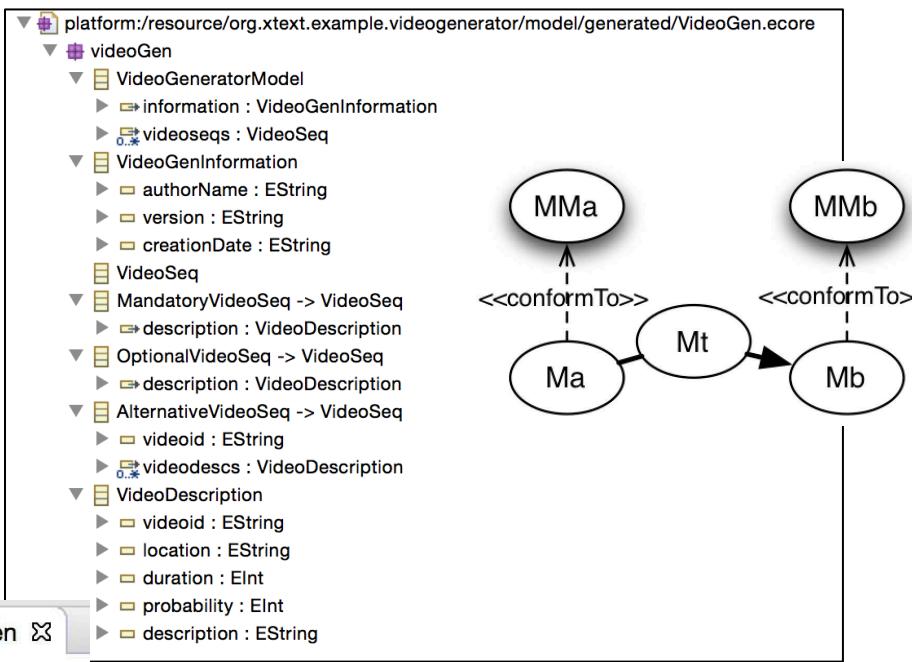
```
vidgen1.videogen  vidgen1-bis.videogen
VideoGen [
    VideoGen1/vidgen1-bis.videogen
        mandatory videoseq v0 "v1/v1.mp4"
        optional videoseq v1 "v2folder/v2.mp4" {
            probability 25
        }
        alternatives vid3 {
            videoseq v2 "v3/seq1.mp4"
            videoseq vid31 "v3/seq2.mp4"
            videoseq vid32 "v3/seq3.mp4"
        }

        alternatives vid4 {
            videoseq vid41 "v4/seq1.mp4"
            videoseq vid42 "v4/seq2.mp4"
        }
        mandatory videoseq vid5 "v5.mp4"

        optional videoseq vid8 "v8.avi"
        alternatives vid9 {
            videoseq vid81 "V81.avi"
        }
}
```

Exogeneous Transformation

(metamodel)



vidgen1.videoegen vidgen1-bis.videoegen

```
VideoGen {
    VideoGen1/vidgen1-bis.videoegen
        mandatory videoseq v0 "v1/v1.mp4"
        optional videoseq v1 "v2folder/v2.mp4" {
            probability 25
        }
        alternatives vid3 {
            videoseq v2 "v3/seq1.mp4"
            videoseq vid31 "v3/seq2.mp4"
            videoseq vid32 "v3/seq3.mp4"
        }

        alternatives vid4 {
            videoseq vid41 "v4/seq1.mp4"
            videoseq vid42 "v4/seq2.mp4"
        }
        mandatory videoseq vid5 "v5.mp4"

        optional videoseq vid8 "v8.avi"
        alternatives vid9 {
            videoseq vid81 "V81.avi"
        }
}
```

```
<ul>
<li>v0</li>
<li>v1</li>
<li>vid3</li>
<ul>
<li>v2</li>
<li>vid31</li>
<li>vid32</li>
</ul>
<li>vid4</li>
<ul>
<li>vid41</li>
<li>vid42</li>
</ul>
<li>vid5</li>
<li>vid8</li>
<li>vid9</li>
<ul>
<li>vid81</li>
</ul>
</ul>
```

Vertical Transformation

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

The screenshot illustrates a vertical transformation setup. On the left, there are two code editors: 'vidgen1.videogen' and 'vidgen1-bis.videogen'. The 'vidgen1.videogen' editor contains Xtext grammar rules for generating video sequences. The 'vidgen1-bis.videogen' editor shows the transformed or generated code. Above the editors is a 'platform:/resource/org.xtext.example.videogenerator/model/generated/VideoGen.ecore' browser window, which displays the Ecore model structure for the VideoGen domain.

vidgen1.videogen:

```
VideoGen {  
    mandatory videoseq "V1/v1.mp4"  
    optional videoseq "v2folder/v2.mp4" {  
        probability 25  
    }  
    alternatives vid3 {  
        videoseq "v3/seq1.mp4"  
        videoseq vid31 "v3/seq2.mp4"  
        videoseq vid32 "v3/seq3.mp4"  
    }  
    alternatives vid4 {  
        videoseq vid41 "v4/seq1.mp4"  
        videoseq vid42 "v4/seq2.mp4"  
    }  
    mandatory videoseq vid5 "v5.mp4"  
  
    optional videoseq vid8 "v8.avi"  
    alternatives vid9 {  
        videoseq vid81 "V81.avi"  
    }  
}
```

vidgen1-bis.videogen:

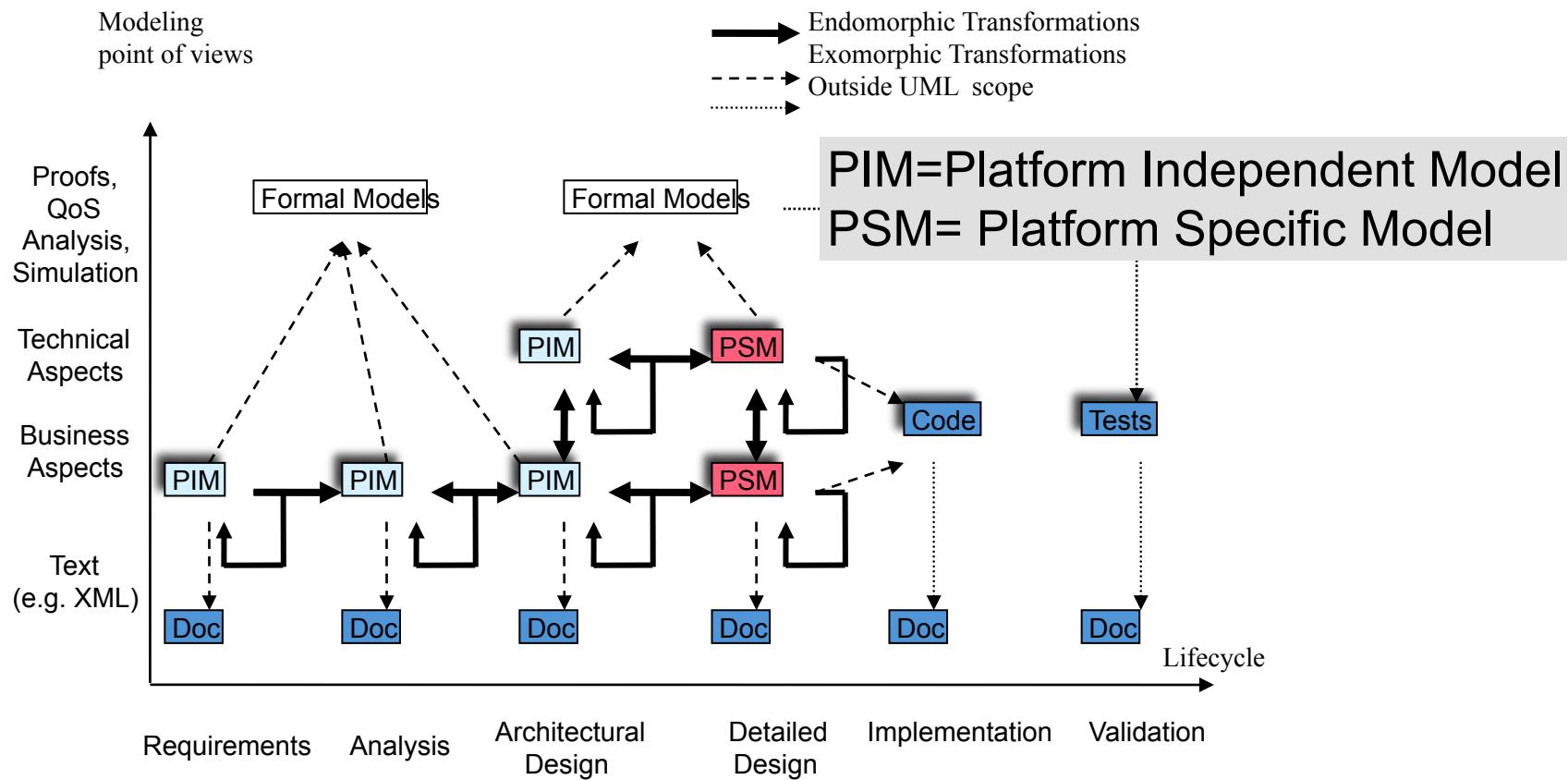
```
VideoGen {  
    mandatory videoseq v0 "v1/v1.mp4"  
    optional videoseq v1 "v2folder/v2.mp4" {  
        probability 25  
    }  
    alternatives vid3 {  
        videoseq v2 "v3/seq1.mp4"  
        videoseq vid31 "v3/seq2.mp4"  
        videoseq vid32 "v3/seq3.mp4"  
    }  
    alternatives vid4 {  
        videoseq vid41 "v4/seq1.mp4"  
        videoseq vid42 "v4/seq2.mp4"  
    }  
    mandatory videoseq vid5 "v5.mp4"  
  
    optional videoseq vid8 "v8.avi"  
    alternatives vid9 {  
        videoseq vid81 "V81.avi"  
    }  
}
```

platform:/resource/org.xtext.example.videogenerator/model/generated/VideoGen.ecore:

- platform:/resource/org.xtext.example.videogenerator/model/generated/VideoGen.ecore
 - videoGen
 - VideoGeneratorModel
 - information : VideoGenInformation
 - videoseqs : VideoSeq
 - VideoGenInformation
 - authorName : EString
 - version : EString
 - creationDate : EString
 - VideoSeq
 - MandatoryVideoSeq -> VideoSeq
 - description : VideoDescription
 - OptionalVideoSeq -> VideoSeq
 - description : VideoDescription
 - AlternativeVideoSeq -> VideoSeq
 - videoid : EString
 - videodescs : VideoDescription
 - VideoDescription
 - videoid : EString
 - location : EString
 - duration : EInt
 - probability : EInt
 - description : EString

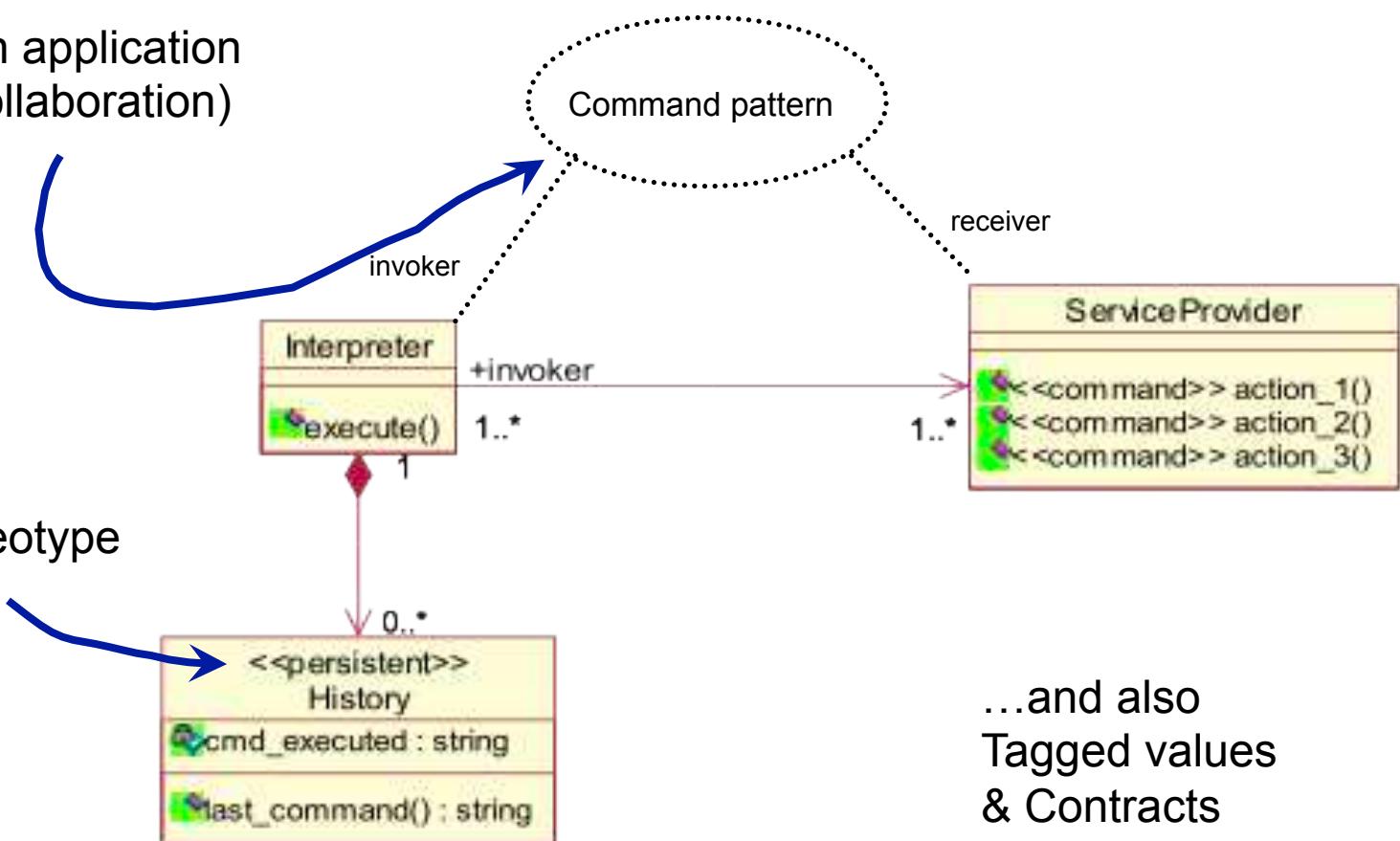
Chaining of Transformations

Back to the first courses

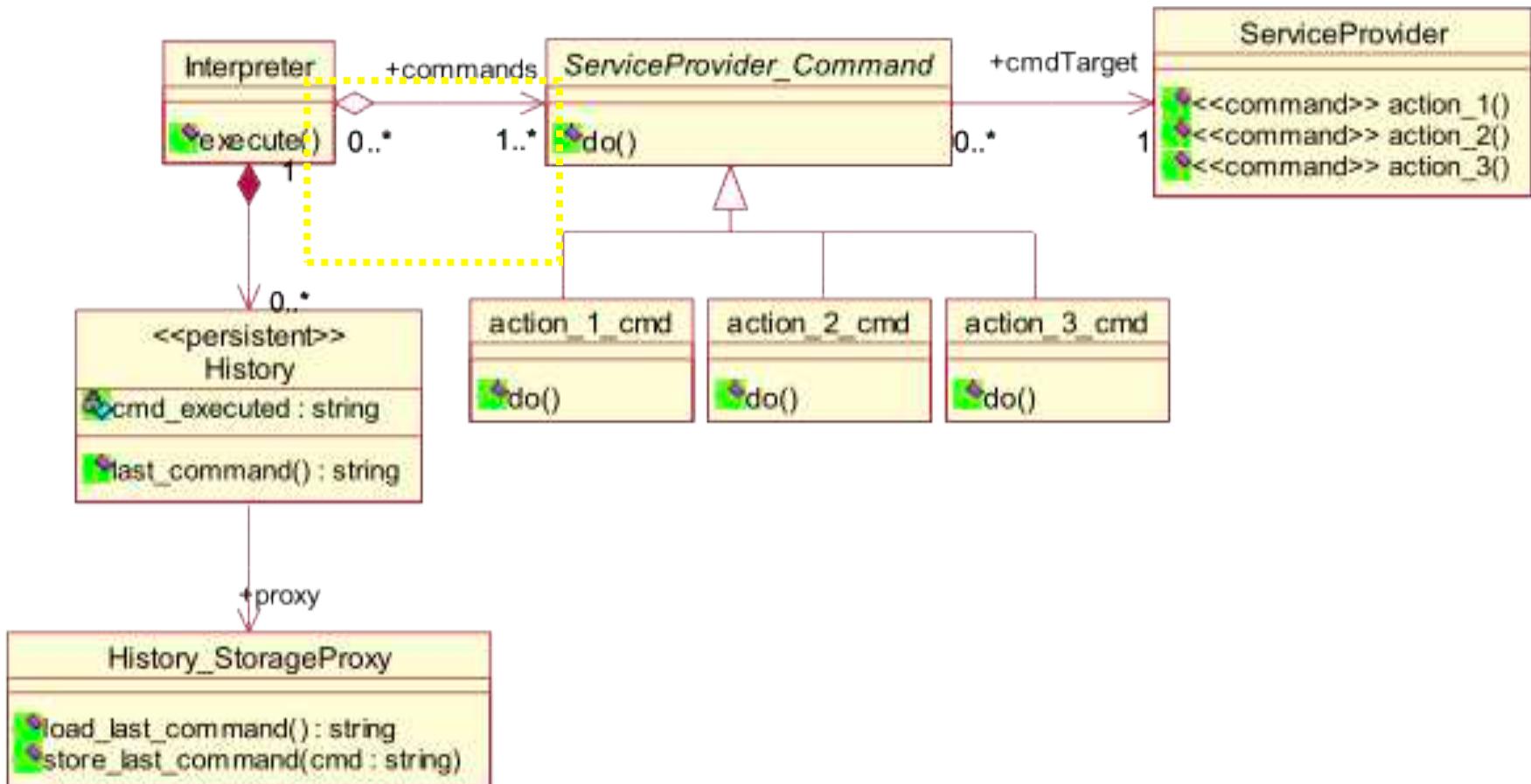


Embedding implicit semantics into a model

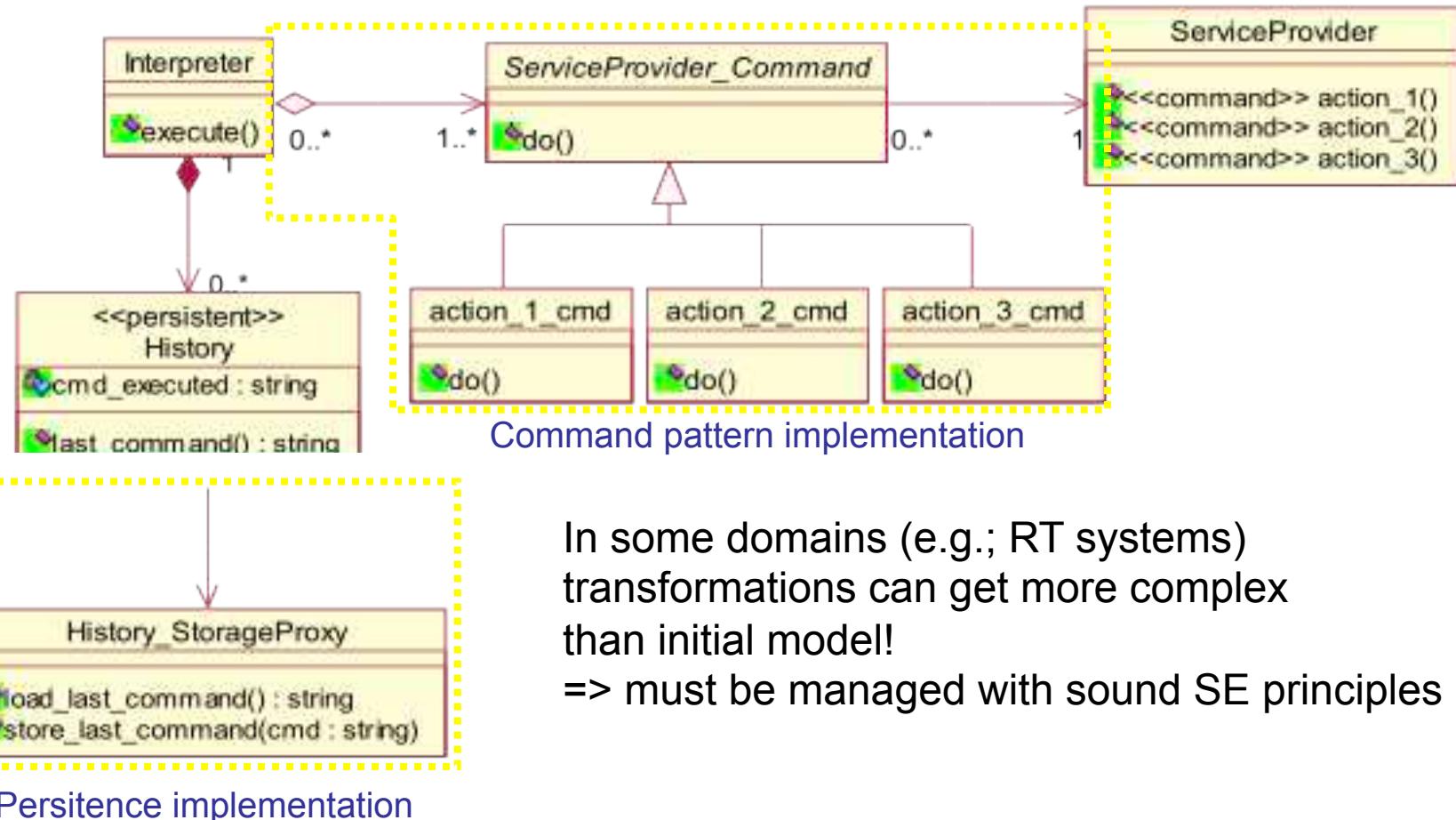
Design pattern application
(parametric collaboration)



...and the result we want...



How To: Automatic Model Transformations



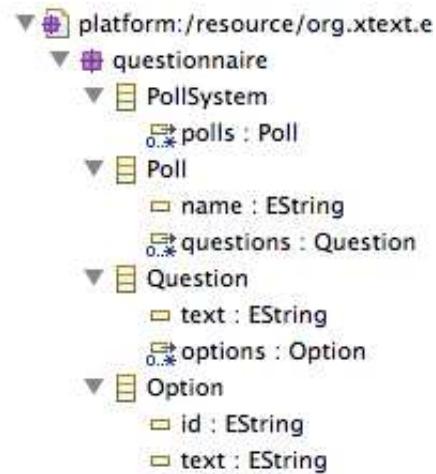
Quizz Time

Characterize the following model transformations

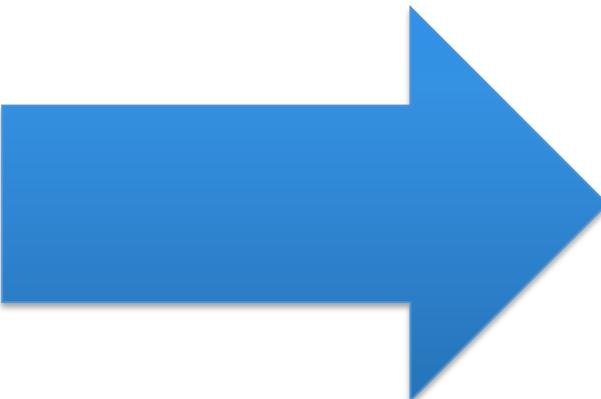
Endogeneous? Exogeneous?

Vertical? Horizontal?

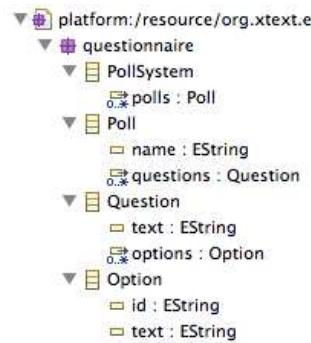
Model-to-text? Model-to-Model?



```
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"
        }
    }
}
```



HTML

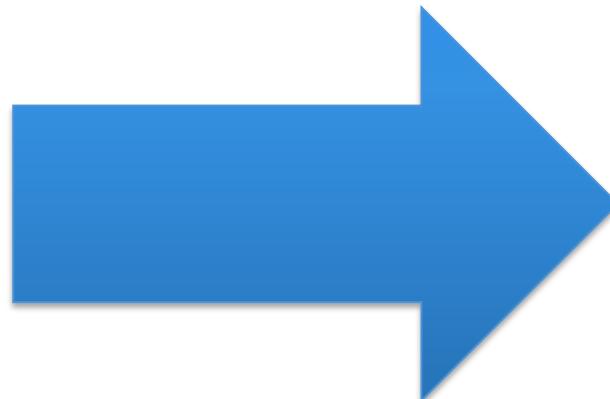


```

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

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 technologies
 - 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 loadVideoGenerator(URI uri) {
    new VideoGenStandaloneSetupGenerated().createInjectorAndDoEMFRegistration()
    var res = new ResourceSetImpl().getResource(uri, true);
    res.contents.get(0) as VideoGeneratorModel
}

```

```

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

```

```

@Test
def test1() {
    // loading
    var videoGen = loadVideoGenerator(URI.createURI("foo2.videogen"))
    assertNotNull(videoGen)
    assertEquals(3, videoGen.videoseqs.size)
    // MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
    videoGen.videoseqs.forEach[videoseq | 
        if (videoseq instanceof MandatoryVideoSeq) {
            val desc = (videoseq as MandatoryVideoSeq).description
            if(desc.videoid.isNullOrEmpty) desc.videoid = genID()
        }
        else if (videoseq instanceof OptionalVideoSeq) {
            val desc = (videoseq as OptionalVideoSeq).description
            if(desc.videoid.isNullOrEmpty) desc.videoid = genID()
        }
        else {
            val altvid = (videoseq as AlternativeVideoSeq)
            if(altvid.videoid.isNullOrEmpty) altvid.videoid = genID()
            for (vdesc : altvid.videodescs) {
                if(vdesc.videoid.isNullOrEmpty) vdesc.videoid = genID()
            }
        }
    ]
    // serializing
    saveVideoGenerator(URI.createURI("foo2bis.xmi"), videoGen)
    saveVideoGenerator(URI.createURI("foo2bis.videogen"), videoGen)
}

```

foo2.videogen

```

VideoGen {
    mandatory videoseq v1 "V1/v1.mp4"
    optional videoseq v2 "v2folder/v2.mp4"
    alternatives v3 {
        videoseq v31 "v31.mp4"
        videoseq v32 "v32.mp4"
    }
}

```

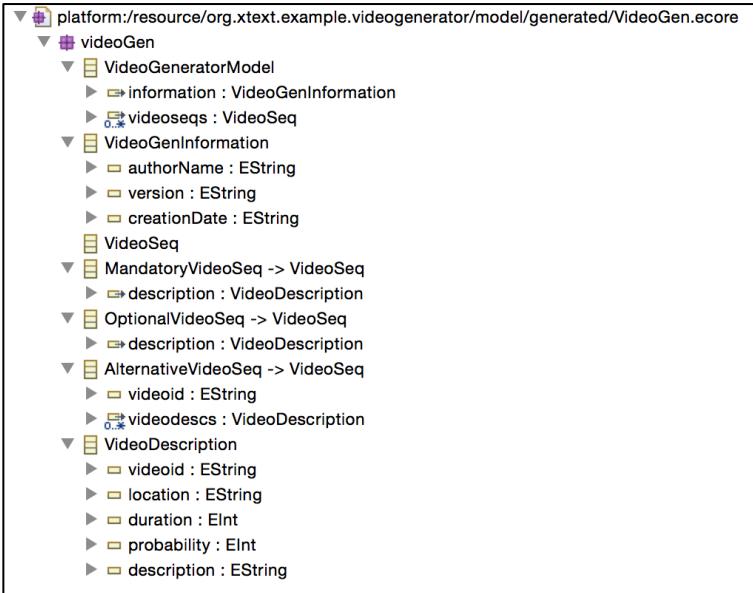
platform:/resource/org.xtext.example.videogenerator/model

```

videoGen
└─ VideoGeneratorModel
    ├─ information : VideoGenInformation
    └─ videoseqs : VideoSeq
VideoGenInformation
└─ authorName : EString
└─ version : EString
└─ creationDate : EString
VideoSeq
└─ MandatoryVideoSeq -> VideoSeq
    ├─ description : VideoDescription
└─ OptionalVideoSeq -> VideoSeq
    ├─ description : VideoDescription
└─ AlternativeVideoSeq -> VideoSeq
    ├─ videoid : EString
    └─ videodescs : VideoDescription
VideoDescription
└─ videoid : EString
└─ location : EString
└─ duration : EInt
└─ probability : EInt
└─ description : EString

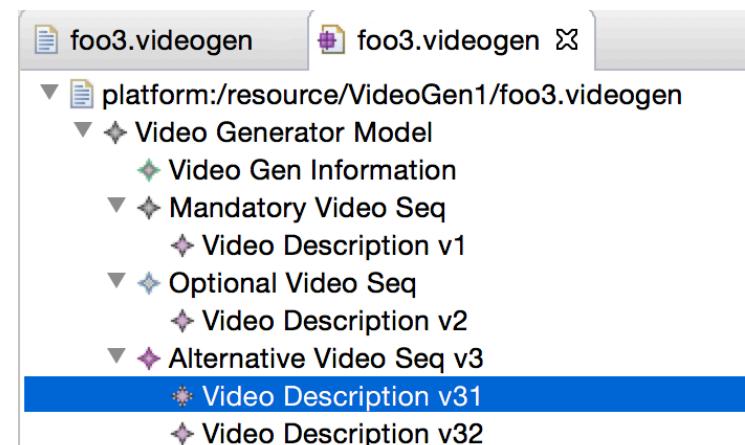
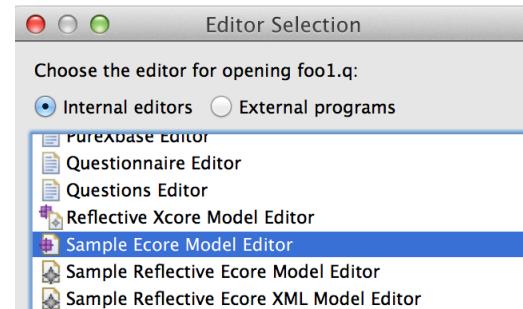
```

Loading Models (1)



foo3.videogen

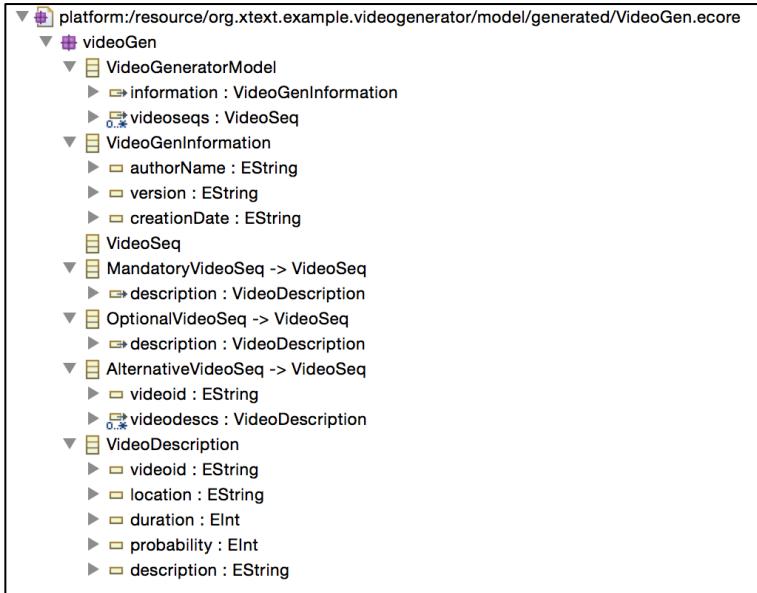
```
VideoGen {  
    mandatory videoseq v1 "V1/v1.mp4"  
    optional videoseq v2 "v2folder/v2.mp4"  
    alternatives v3 {  
        videoseq v31 "v31.mp4"  
        videoseq v32 "v32.mp4"  
    }  
}
```



Properties

Property	Value
Description	
Duration	0
Location	v31.mp4
Probability	0
Videoid	v31

Loading Models (2)



Persistence of Models in XMI (XML Metadata Interchange)

The screenshot shows the Xtext IDE interface. On the left, there's a code editor with the following Xtext grammar:

```
VideoGen {
    mandatory videotoseq v1 "V1/v1.mp4"
    optional videotoseq v2 "v2folder/v2.mp4"
    alternatives v3 {
        videotoseq v31 "v31.mp4"
        videotoseq v32 "v32.mp4"
    }
}
```

In the center, a tree view displays the persisted XMI structure for `foo3.videogen`:

```
platform:/resource/VideoGen1/foo3.videogen
  Video Generator Model
    Video Gen Information
    Mandatory Video Seq
      Video Description v1
    Optional Video Seq
      Video Description v2
    Alternative Video Seq v3
      Video Description v31
      Video Description v32
```

On the right, a properties view shows the values for the selected `Video Description v31` node:

Property	Value
Description	
Duration	0
Location	v31.mp4
Probability	0
Videoid	v31

```
<?xml version="1.0" encoding="ASCII"?>
<videoGen:VideoGeneratorModel xmi:version="2.0" xmlns:xmi="http://www.omg.org/XMI">
  <information/>
  <videotoseqs xsi:type="videoGen:MandatoryVideoSeq">
    <description videoid="v1" location="V1/v1.mp4"/>
  </videotoseqs>
  <videotoseqs xsi:type="videoGen:OptionalVideoSeq">
    <description videoid="v2" location="v2folder/v2.mp4"/>
  </videotoseqs>
  <videotoseqs xsi:type="videoGen:AlternativeVideoSeq" videoid="v3">
    <videodescs videoid="v31" location="v31.mp4"/>
    <videodescs videoid="v32" location="v32.mp4"/>
  </videotoseqs>
</videoGen:VideoGeneratorModel>
```

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

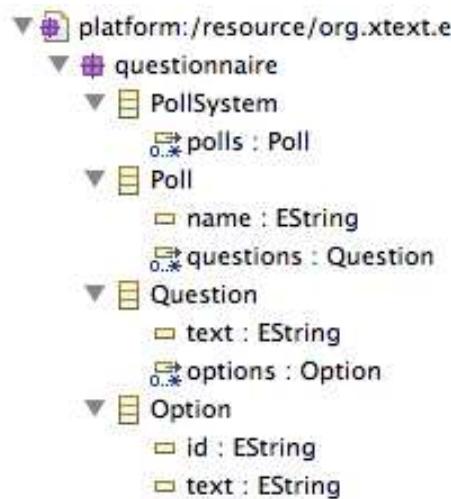
```
def savePollSystem(URI uri, PollSystem pollS) {
    var Resource rs = new ResourceSetImpl().createResource(uri);
    rs.getContents.add(pollS);
    rs.save(new HashMap());
}
```

```
@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)
}
```



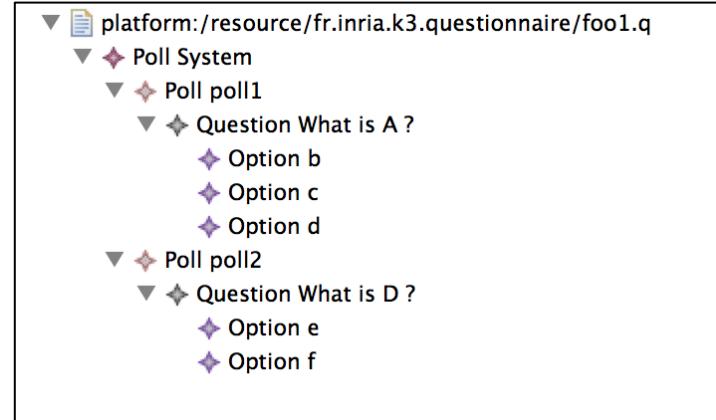
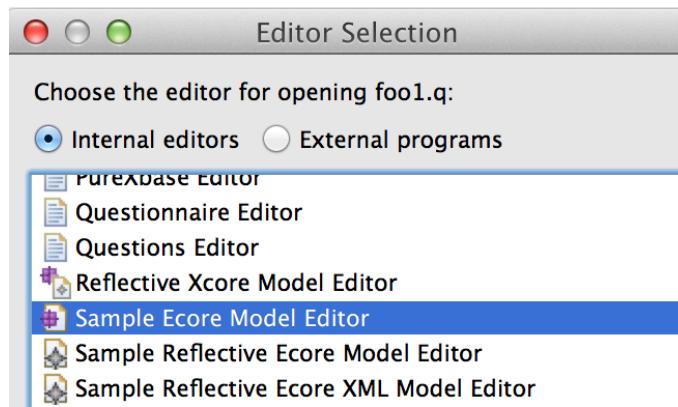
Loading Models (1)

The screenshot illustrates the process of loading a UML-like questionnaire model into a tool.

Top Right: A tree view of the model structure under `platform:/resource/org.xtext.e`:

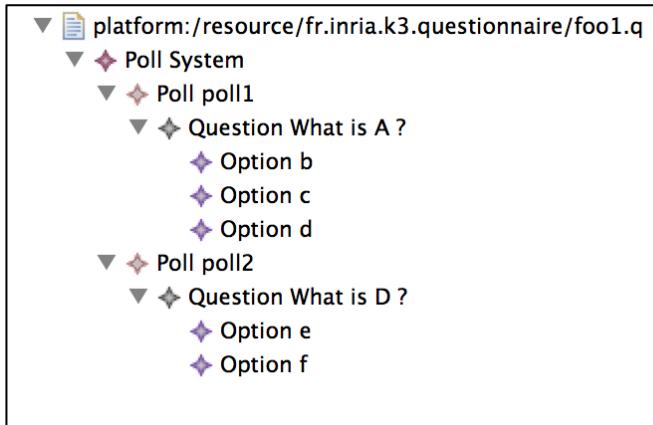
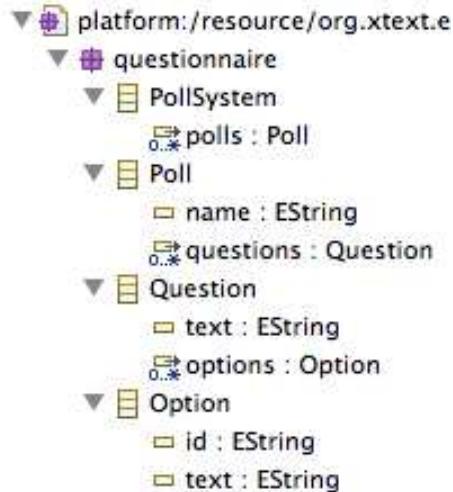
- `questionnaire`
 - `PollSystem`
 - `polls : Poll`
 - `Poll`
 - `name : EString`
 - `questions : Question`
 - `Question`
 - `text : EString`
 - `options : Option`
 - `Option`
 - `id : EString`
 - `text : EString`

```
foo.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)

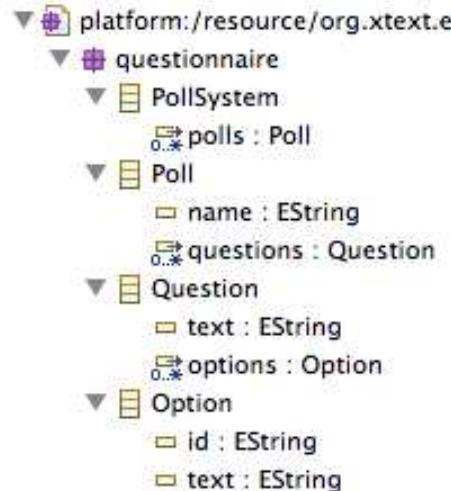
```
foo1.q
PollSystem {
    Poll poll1 {
        Question A {
            "What is A ?"
            options
                b : "B"
                c : "C"
                d : "D"
        }
    }
    Poll poll2 {
        Question D {
            "What is D ?"
            options
                e : "E"
                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)

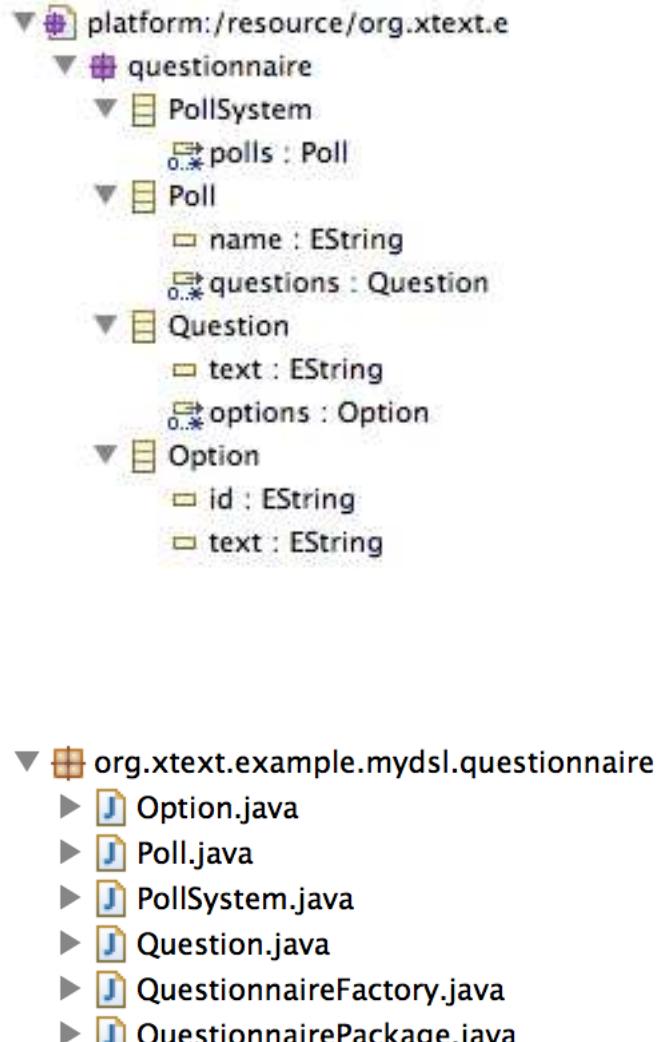


```
foo1.q
fool.q
PollSystem {
    Poll poll1 {
        Question A {
            "What is A ?"
            options
                b : "B"
                c : "C"
                d : "D"
        }
    }
    Poll poll2 {
        Question D {
            "What is D ?"
            options
                e : "E"
                f : "F"
        }
    }
}
```

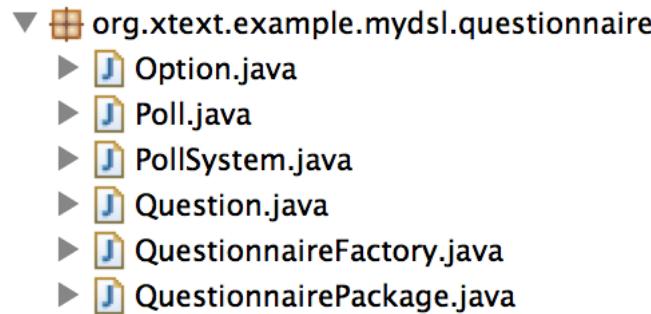
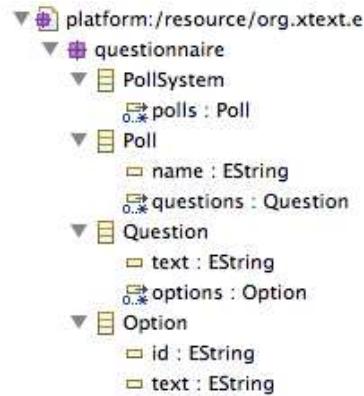
Persistence of Models in XMI (XML Metadata Interchange)

```
<?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



Meta(models) and Java



```
public interface Poll extendsEObject
{
  /**
   * Returns the value of the '<em><b>name</b></em>' attribute.
   * <!-- begin-user-doc -->
   * <p>
   * 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.
   * <!-- user-doc -->
   * $R org.xtext.example.mydsl.questionnaire.QuestionnairePackage#getPoll_Name()
   * #model
   * #generated
   * String getName();
  */

  /**
   * Sets the value of the '<em><b>name</b></em>' attribute.
   * <!-- begin-user-doc -->
   * <p>
   * The value the new value of the '<em>name</em>' attribute.
   * </p>
   * <!-- end-user-doc -->
   * 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>
   * 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.
   * $R org.xtext.example.mydsl.questionnaire.QuestionnairePackage#getPoll_Questions()
   * #model
   * #generated
   * EList<Question> getQuestions();
  */

  // // Poll
}

// Generated
void setText(String value);

/* Text */
```

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



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



ECLIPSE MODELING FRAMEWORK

Ecore Model

EPackage

EClass

EAttribute

EReference

Code generation



Java Code

Package

Class

Attribute

Reference

```
fool.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"
        }

    }

}

```

```
fool.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"
        }

    }

}

```

```
def loadPollSystem(URL url) {
    new QuestionnaireStandaloneSetupGenerated().createInjectorAndDoEMFRegistration()
    var res = new ResourceSetImpl().getResources(url, true);
    res.getContents().get(0) as PollSystem
}

def savePollSystem(URL url, PollSystem polls) {
    var ResourceSet rs = new ResourceSetImpl().createResource(url);
    rs.getContents().add(polls);
    rs.save(new HashMap());
}

@Test
def testIO() {
    // loading
    var polls = loadPollSystem(URL.createURI("fool.q"))
    assertNotNull(polls)
    assertEquals(2, polls.size)

    // MODEL MANAGEMENT ANALYSIS, TRANSFORMATION
    polls.polls.forEach{p| p.name = p.name + ".poll"}
    // serializing
    savePollSystem(URL.createURI("foo2.q"), polls)
}
```

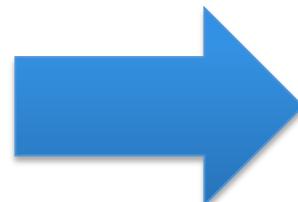
Questionnaire MM (ecore)

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
}
```

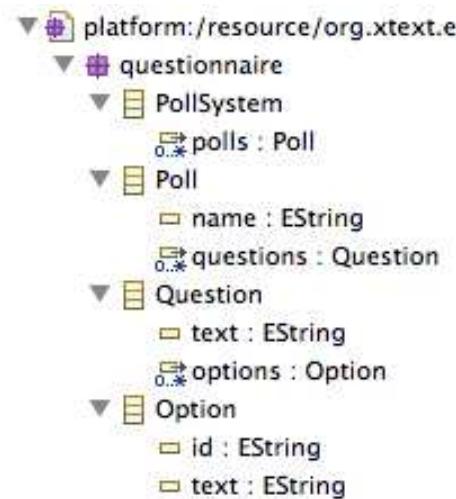
```
def savePollSystem(URI uri, PollSystem pollS) {
    var Resource rs = new ResourceSetImpl().createResource(uri);
    rs.getContents.add(pollS);
    rs.save(new HashMap());
}
```

```
@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"))

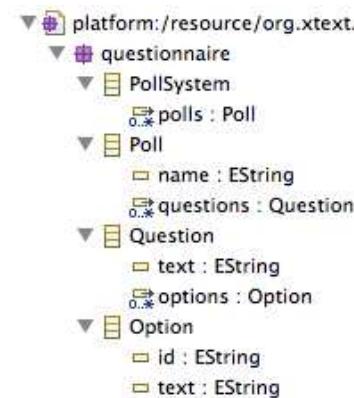
    // MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
    var html = toPolls(pollS.polls)
    assertNotNull(html)

    // 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>
}

```



poll1

What is A ?

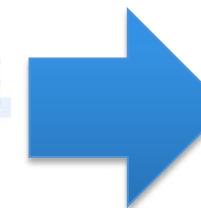
- B
- C
- D

foo1.q

```

class 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"
        }
    }
}

```



poll2

What is D ?

- E
- F

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)

What are the problems with this Xtext grammar?

```
grammar org.xtext.example.mydsl.VideoGen with org.eclipse.xtext.common.Terminals

generate videoGen "http://www.xtext.org/example/mydsl/VideoGen"

VideoGeneratorModel:
    'VideoGen' LEFT_BRACKET
    videoseqs+=VideoSeq+
    RIGHT_BRACKET
    ;

VideoSeq: MandatoryVideoSeq | OptionalVideoSeq | AlternativeVideoSeq ;

MandatoryVideoSeq : 'mandatory' VideoDescription;
OptionalVideoSeq : 'optional' VideoDescription;
AlternativeVideoSeq : 'alternatives' (videoid=ID)? LEFT_BRACKET
    videodescs+=VideoDescription+ RIGHT_BRACKET
    ;

VideoDescription : 'videoseq' videoid=ID STRING
    ;

terminal LEFT_BRACKET: '{' ;
terminal RIGHT_BRACKET: '}' ;
```

```

grammar org.xtext.example.mydsl.VideoGen with org.eclipse.xtext.common.Terminals

generate videoGen "http://www.xtext.org/example/mydsl/VideoGen"

VideoGeneratorModel:
    'VideoGen' LEFT_BRACKET
    videoseqs+=VideoSeq+
    RIGHT_BRACKET
;

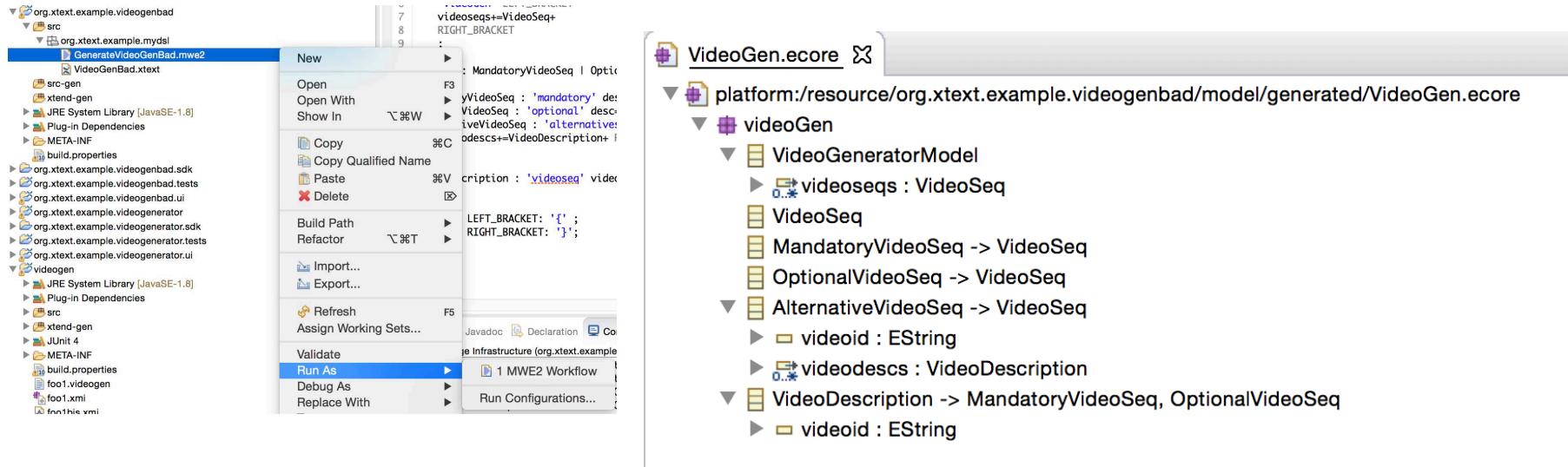
VideoSeq: MandatoryVideoSeq | OptionalVideoSeq | AlternativeVideoSeq ;

MandatoryVideoSeq : 'mandatory' VideoDescription;
OptionalVideoSeq : 'optional' VideoDescription;
AlternativeVideoSeq : 'alternatives' (videoid=ID)? LEFT_BRACKET
    videodescs+=VideoDescription+ RIGHT_BRACKET
;

VideoDescription : 'videoseq' videoid=ID STRING
;

terminal LEFT_BRACKET: '{';
terminal RIGHT_BRACKET: '}';

```



```

grammar org.xtext.example.mydsl.VideoGen with org.eclipse.xtext.common.Terminals

generate videoGen "http://www.xtext.org/example/mydsl/VideoGen"

VideoGeneratorModel:
    'VideoGen' LEFT_BRACKET
    videoseqs+=VideoSeq+
    RIGHT_BRACKET
;

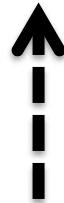
VideoSeq: MandatoryVideoSeq | OptionalVideoSeq | AlternativeVideoSeq ;

MandatoryVideoSeq : 'mandatory' VideoDescription;
OptionalVideoSeq : 'optional' VideoDescription;
AlternativeVideoSeq : 'alternatives' (videoid=ID)? LEFT_BRACKET
    videodescs+=VideoDescription+
    RIGHT_BRACKET
;

VideoDescription : 'videoseq' videoid=ID STRING
;

terminal LEFT_BRACKET: '{';
terminal RIGHT_BRACKET: '}';

```

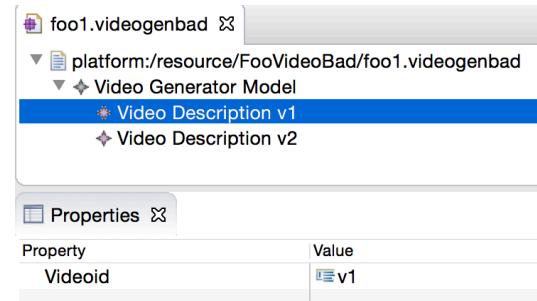
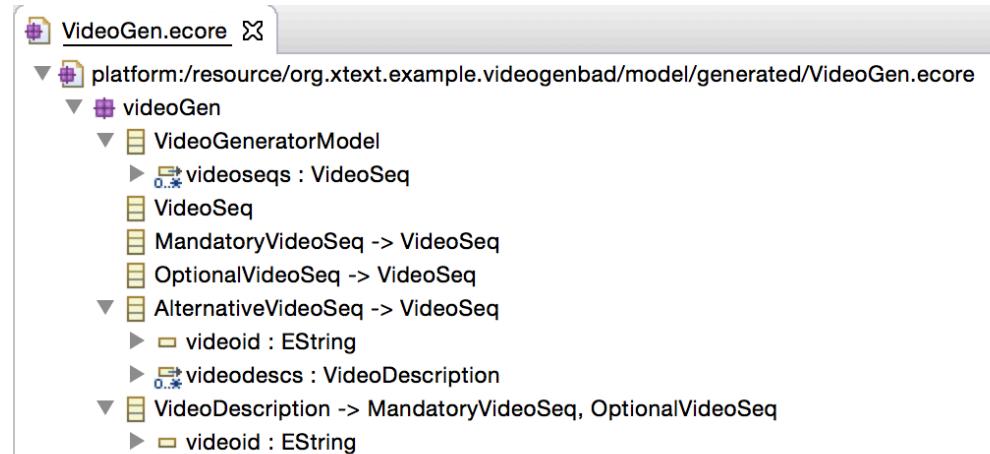


foo1.videogenbad

```

VideoGen {
    mandatory videoseq v1 "v1.avi"
    optional videoseq v2 "v2.mp4"
}

```

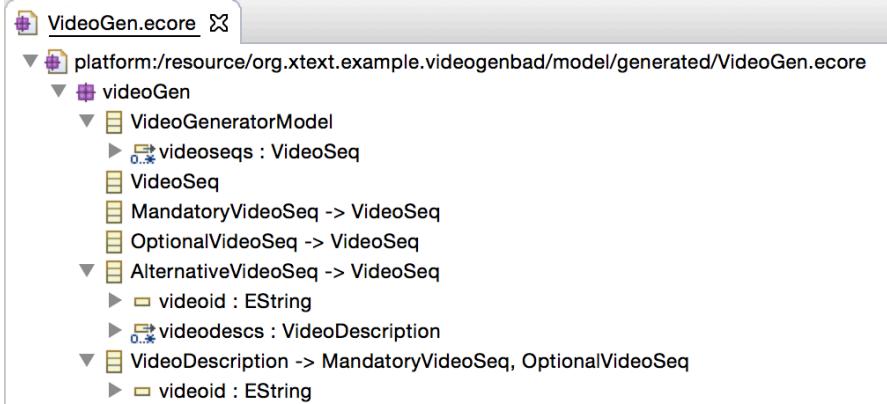


foo1.videoogenbad

```

VideoGen {
    mandatory videoseq v1 "v1.avi"
    optional videoseq v2 "v2.mp4"
}

```



```

def loadVideoGenerator(URI uri) {
    new VideoGenStandaloneSetupGenerated().createInjectorAndDoEMFRegistration()
    var res = new ResourceSetImpl().getResource(uri, true);
    res.contents.get(0) as VideoGeneratorModel
}

@Test
def test1() {

    // loading
    var videoGen = loadVideoGenerator(URI.createURI("foo1.videoogenbad"))
    assertNotNull(videoGen)

    // MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
    assertEquals(2, videoGen.videoseqs.size)

    // MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
    videoGen.videoseqs.forEach[videoseq] {
        if (videoseq instanceof MandatoryVideoSeq) {
            val desc = (videoseq as MandatoryVideoSeq).description
            // ...
        }
    }
}

```

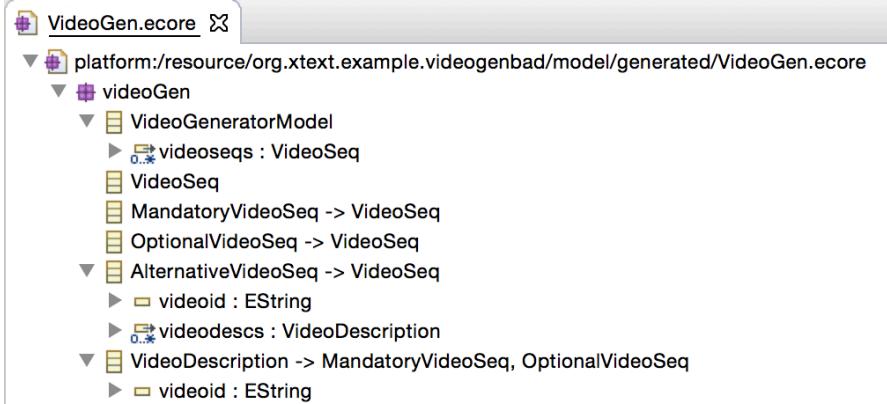
The method description is undefined....

foo1.videoogenbad

```

VideoGen {
    mandatory videoseq v1 "v1.avi"
    optional videoseq v2 "v2.mp4"
}

```



```

def loadVideoGenerator(URI uri) {
    new VideoGenStandaloneSetupGenerated().createInjectorAndDoEMFRegistration()
    var res = new ResourceSetImpl().getResource(uri, true);
    res.contents.get(0) as VideoGeneratorModel
}

@Test
def test1() {

    // loading
    var videoGen = loadVideoGenerator(URI.createURI("foo1.videoogenbad"))
    assertNotNull(videoGen)

    // MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
    assertEquals(2, videoGen.videoseqs.size)

    // MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
    videoGen.videoseqs.forEach[videoseq] {
        if (videoseq instanceof MandatoryVideoSeq) {
            val desc = (videoseq as MandatoryVideoSeq).description
            // ...
        }
    }
}

```

The method description is undefined....

The screenshot shows a software interface for editing UML-like models. At the top, there's a toolbar with icons for file operations like New, Open, Save, etc. Below the toolbar is a title bar labeled "VideoGen.ecore". The main area is divided into two panes. The left pane displays the model structure as a tree view:

- platform:/resource/org.xtext.example.videogenbad/model/generated/VideoGen.ecore
- videoGen
 - VideoGeneratorModel
 - videoseqs : VideoSeq
 - VideoSeq
 - MandatoryVideoSeq -> VideoSeq
 - OptionalVideoSeq -> VideoSeq
 - AlternativeVideoSeq -> VideoSeq
 - videoid : EString
 - videodescs : VideoDescription
 - VideoDescription -> MandatoryVideoSeq, OptionalVideoSeq
 - videoid : EString

```
grammar org.xtext.example.mydsl.VideoGen with org.eclipse.xtext.common.Terminals
```

```
generate videoGen "http://www.xtext.org/example/mydsl/VideoGen"
```

```
VideoGeneratorModel:
```

```
    'VideoGen' LEFT_BRACKET  
    videoseqs+=VideoSeq+  
    RIGHT_BRACKET  
    ;
```

```
VideoSeq: MandatoryVideoSeq | OptionalVideoSeq | AlternativeVideoSeq ;
```

```
MandatoryVideoSeq : 'mandatory' VideoDescription;
```

```
OptionalVideoSeq : 'optional' VideoDescription;
```

```
AlternativeVideoSeq : 'alternatives' (videoid=ID)? LEFT_BRACKET  
    videodescs+=VideoDescription+ RIGHT_BRACKET  
;
```

```
VideoDescription : 'videoseq' videoid=ID STRING  
    ;
```

```
terminal LEFT_BRACKET: '{' ;
```

```
terminal RIGHT_BRACKET: '}' ;
```

deoGen.ecore

| platform:/resource/org.xtext.example.videogenbad/model/generated/VideoGen.ecore

videoGen

VideoGeneratorModel

videoseqs : VideoSeq

VideoSeq

MandatoryVideoSeq -> VideoSeq

OptionalVideoSeq -> VideoSeq

AlternativeVideoSeq -> VideoSeq

videoid : EString

videodescs : VideoDescription

VideoDescription -> MandatoryVideoSeq, OptionalVideoSeq

videoid : EString

```
1  /**  
2  * package org.xtext.example.mydsl.videoGen;  
3  *  
4  *  
5  *  
6  * <!-- begin-user-doc -->  
7  * A representation of the model object 'Mandatory Video Seq'.  
8  * <!-- end-user-doc -->  
9  *  
10 *  
11 *  
12 * @see org.xtext.example.mydsl.videoGen.VideoGenPackage#getMandatoryVideoSeq()  
13 * @model  
14 * @generated  
15 */  
16 public interface MandatoryVideoSeq extends VideoSeq  
17 {  
18 } // MandatoryVideoSeq  
19
```

Fixing the grammar

```
grammar org.xtext.example.mydsl.VideoGen with org.eclipse.xtext.common.Terminals

generate videoGen "http://www.xtext.org/example/mydsl/VideoGen"

VideoGeneratorModel:
    'VideoGen' LEFT_BRACKET
    videoseqs+=VideoSeq+
    RIGHT_BRACKET
;

VideoSeq: MandatoryVideoSeq | OptionalVideoSeq | AlternativeVideoSeq ;

MandatoryVideoSeq : 'mandatory' description=VideoDescription;
OptionalVideoSeq : 'optional' VideoDescription;
AlternativeVideoSeq : 'alternatives' (videoid=ID)? LEFT_BRACKET
    videodescs+=VideoDescription+
    RIGHT_BRACKET
;

VideoDescription : videoseq' videoid=ID STRING
;

terminal LEFT_BRACKET: '{' ;
terminal RIGHT_BRACKET: '}' ;
```

platform:/resource/org.xtext.example.videogenbad/model/generated/VideoGen.ecore

- videoGen
 - VideoGeneratorModel
 - videoseqs : VideoSeq
 - VideoSeq
 - MandatoryVideoSeq -> VideoSeq
 - description : VideoDescription
 - OptionalVideoSeq -> VideoSeq
 - AlternativeVideoSeq -> VideoSeq
 - videoid : EString
 - videodescs : VideoDescription
 - VideoDescription -> OptionalVideoSeq
 - videoid : EString

```

1 /**
2 */
3 package org.xtext.example.mydsl.videoGen;
4
5 /**
6 * <!-- begin-user-doc -->
7 * A representation of the model object 'Mandatory Video Seq'.
8 * <!-- end-user-doc -->
9 *
10 * <p>
11 * The following features are supported:
12 * </p>
13 * <ul>
14 * <li>{@link org.xtext.example.mydsl.videoGen.MandatoryVideoSeq#getDescription Description}</li>
15 * </ul>
16 *
17 * @see org.xtext.example.mydsl.videoGen.VideoGenPackage#getMandatoryVideoSeq()
18 * @model
19 * @generated
20 */
21 public interface MandatoryVideoSeq extends VideoSeq
22 {
23 /**
24 * Returns the value of the 'Description' containment reference.
25 * <!-- begin-user-doc -->
26 * <!-- If the meaning of the 'Description' containment reference isn't clear,
27 * there really should be more of a description here...
28 * </p>
29 * <!-- end-user-doc -->
30 * @return the value of the 'Description' containment reference.
31 * @see #setDescription(VideoDescription)
32 * @see org.xtext.example.mydsl.videoGen.VideoGenPackage#getMandatoryVideoSeq_Description()
33 * @model containment="true"
34 * @generated
35 */
36 VideoDescription getDescription();
37
38 /**
39 * Sets the value of the '{@link org.xtext.example.mydsl.videoGen.MandatoryVideoSeq#getDescription Description}' containment reference.
40 * <!-- begin-user-doc -->
41 * <!-- end-user-doc -->
42 * @param value the new value of the 'Description' containment reference.
43 * @see #getDescription()
44 * @generated
45 */
46 void setDescription(VideoDescription value);
47
48 } // MandatoryVideoSeq

```

// loading

```

var videoGen = loadVideoGenerator(URI.createURI("foo1.videogenbad"))
assertNotNull(videoGen)

// MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
assertEquals(2, videoGen.videoseqs.size)

// MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
videoGen.videoseqs.forEach[videoseq {
    if (videoseq instanceof MandatoryVideoSeq) {
        val desc = (videoseq as MandatoryVideoSeq).description
        // ...
    }
}]

```

Grammar and Metamodel

- Model transformations are defined on top of metamodel constructs
- **Co-design** of grammar and metamodel
 - Grammar defines the syntax
 - Metamodel defines the structure
 - Xtext facilitates the metamodel design with
 - Default rules for inferring the metamodel from the grammar
 - Facilities to parameterize the inference
- Some transformations may be difficult to express. In this case two possible attitudes:
 - Revise the Xtext grammar and the underlying metamodel
 - Design another metamodel (from scratch) and write a model-to-model transformation

Plan

- Model Management in a nutshell
 - Loading, serializing, transforming models: scenarios
 - Taxonomy
 - Model transformation in Xtend
- Xtend: a case study for GPL/DSL, MDE, and model transformation
 - Advanced features: extension methods, active annotations, template expressions
 - Xtend: behing the magic (Xtext+MDE)
 - Xtend + Xtext (breathing life into DSLs)
 - @Aspect annotation

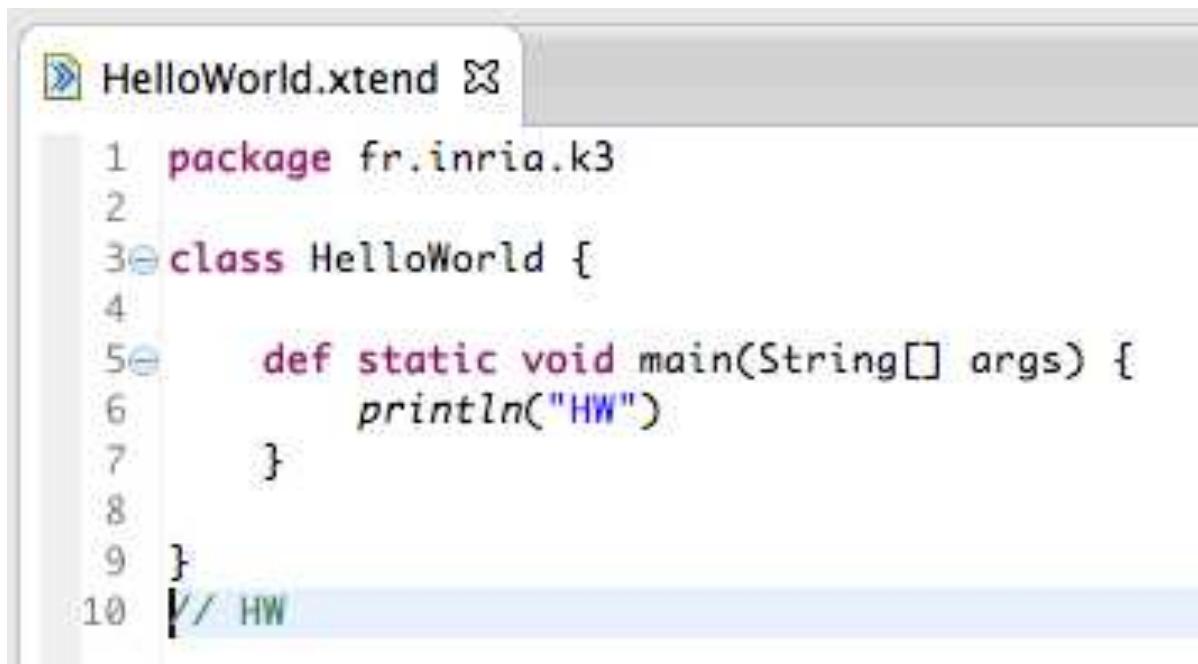
Contract

- Practical foundations of model management
- Model transformations
 - Model-to-Text
 - Model-to-Model
 - Metaprogramming
- DSLs and model management: all together (Xtext + Xtend)

Xtend

The Basics
(~ Java cheatsheet)

Hello World



The screenshot shows a code editor window titled "HelloWorld.xtend". The code is written in a language that appears to be a dialect of Java, specifically K3. The code defines a class named "HelloWorld" with a main method that prints "HW". The code is numbered from 1 to 10.

```
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 }
```

Package Declaration

A screenshot of a code editor showing the `HelloWorld.xtend` file. The code is: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]The tab bar shows `HelloWorld.xtend` is the active file.

Semi-colon ';' is optional

A screenshot of a code editor showing two files: `HelloWorld.xtend` and `PackageExploder.xtend`. The `HelloWorld.xtend` file contains:1 package fr.inria.k3.^def
2
3 class PackageExploder {
4
5 }The `PackageExploder.xtend` file is also visible in the background.

'^' 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 }
```

A code editor window showing a Scala file named FooMethod.scala. The code defines a class FooMethod with four methods: foo1, foo2, foo3, and foo4. foo1 returns a string "A". foo2 returns the sum of 6 and 3. foo3 is a private method that returns the sum of 6 and 3. foo4 is a public method that returns the product of foo3's result and 8. Below this, another class FooMethodUses is defined with a method fooUse that creates instances of FooMethod and calls its methods. At line 30, there is a call to 'new FooMethod().f]'. A tooltip appears over this line, listing three options: 'foo1 : String - FooMethod.foo1()', 'foo2 : int - FooMethod.foo2()', and 'foo4 : int - FooMethod.foo4()'. Lines 26 and 30 have red X marks next to them, indicating they are errors.

By default:
visibility
conditions set
to public

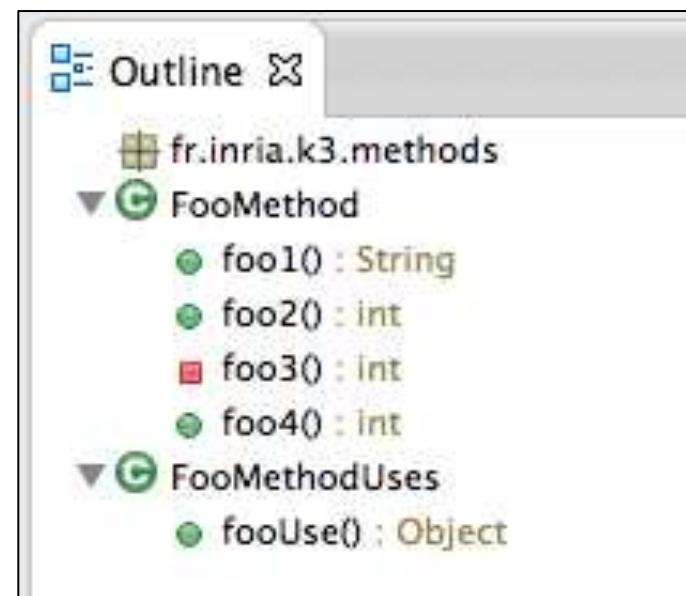
```
>HelloWorld.xtend ☐
1 package fr.inria.k3
2
3 class HelloWorld {
4
5     def static void main(String[] args) {
6         println("HW")
7     }
8
9 }
10 [/ HW
```

A code editor window showing a Scala file named HelloWorld.xtend. It contains a single class HelloWorld with a static main method that prints "HW" to the console. The file is currently empty at the bottom.

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 }
```

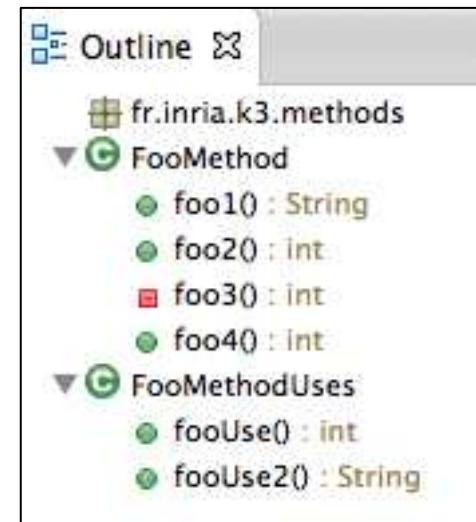
Type inference (return type)



Method Calling

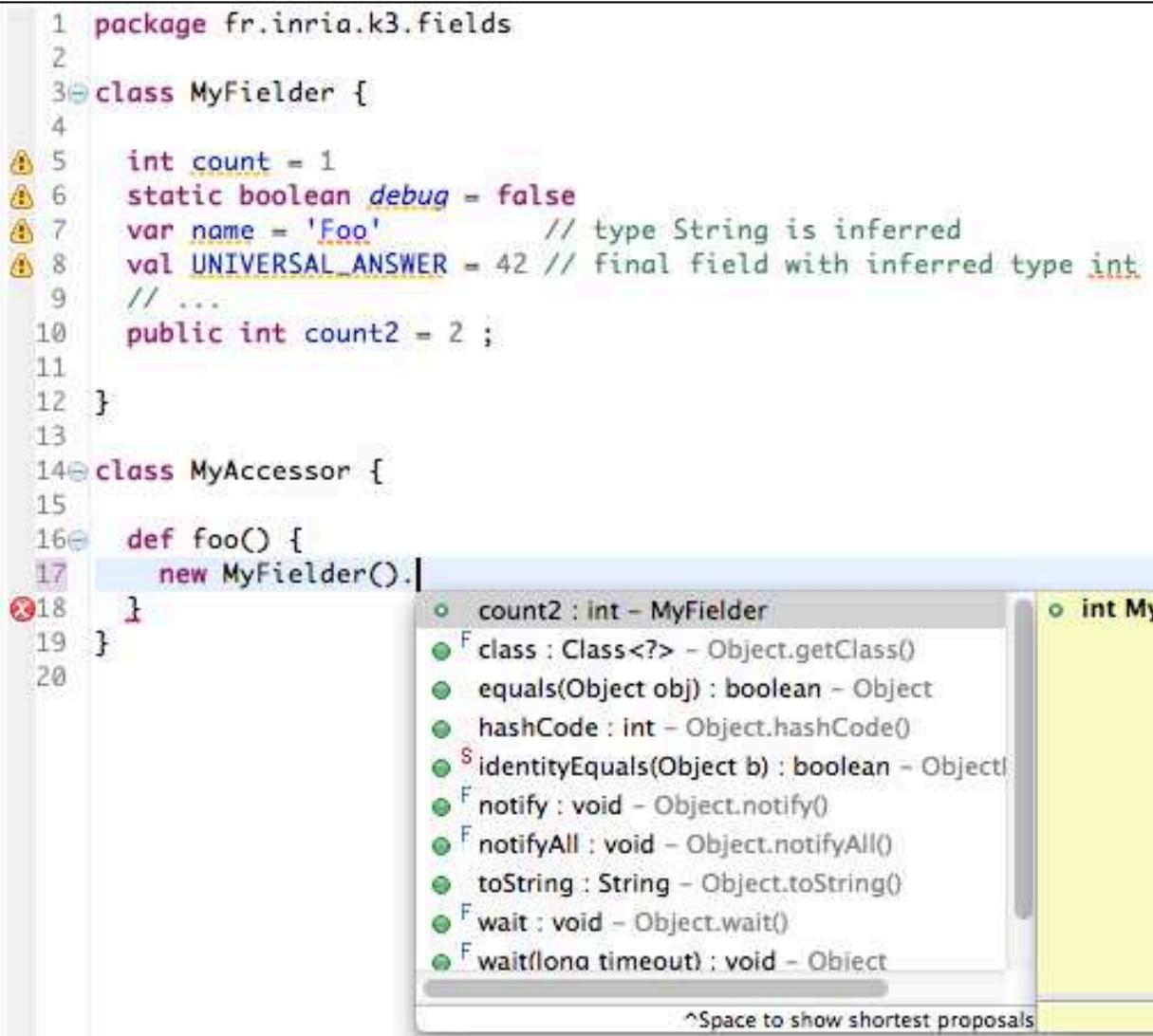
You can omit
parentheses

```
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

```
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
14 class MyAccessor {
15
16     def foo() {
17         new MyFielder().|
18     }
19 }
```



The screenshot shows a Java code editor with the following code:

```
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
14 class MyAccessor {
15
16     def foo() {
17         new MyFielder().|
18     }
19 }
```

A code completion tooltip is displayed over the line `new MyFielder().|`. The tooltip contains the following list of suggestions:

- count2 : int - MyFielder
- getClass : Class<?> - Object.getClass()
- equals(Object obj) : boolean - Object
- hashCode : int - Object.hashCode()
- identityEquals(Object b) : boolean - Object
- notify : void - Object.notify()
- notifyAll : void - Object.notifyAll()
- toString : String - Object.toString()
- wait : void - Object.wait()
- wait(long timeout) : void - Object

At the bottom of the tooltip, there is a message: "Space to show shortest proposals".

**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 }
```

fr.inria.k3.pairs
FooSugar
pair : Pair<String, String>
k : String
v : String
foo() : String

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 }
```



The screenshot shows the IntelliJ IDEA interface with the 'Console' tool window open. The console output shows the results of the program execution:

```
<terminated> FooSugar [Java Application] /Library/Java/JavaVirtualMachine
HW in english : Hello
HW in french : Bonjour
HW in german : Hallo
```

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/
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")
```

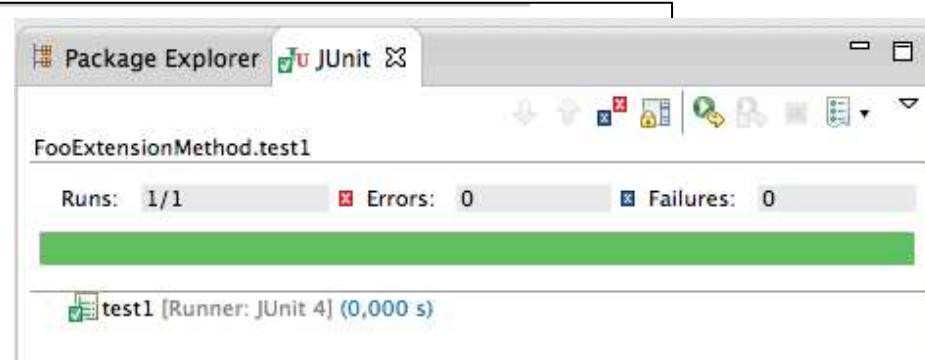
or as an extension method of String:

```
"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 referring to the first parameter  
    var (String)=>int l3 = [length] // we can even omit it or the first parameter  
  
    @Test  
    def test1() {  
        assertEquals(l.apply ("RRRR"), l2.apply("PPPP"))  
        assertEquals(l2.apply ("RRRR"), l3.apply("PPPP"))  
    }  
}
```

▼  FooLambda

- l : Function1<String, Integer>
- l2 : (String)=>int
- l3 : (String)=>int
- test1() : void

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 }
```

```

@Test
def test2() {

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

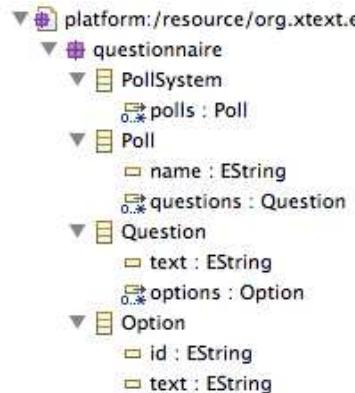
    // MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
    var html = toPolls(pollS.polls)
    assertNotNull(html)

    // 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 (2)



poll1

What is A ?

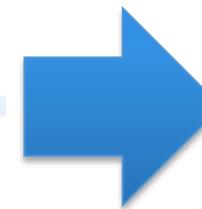
- B
- C
- D

foo1.q

```

fool.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"
        }
    }
}

```



poll2

What is D ?

- E
- F

Templates (3)

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

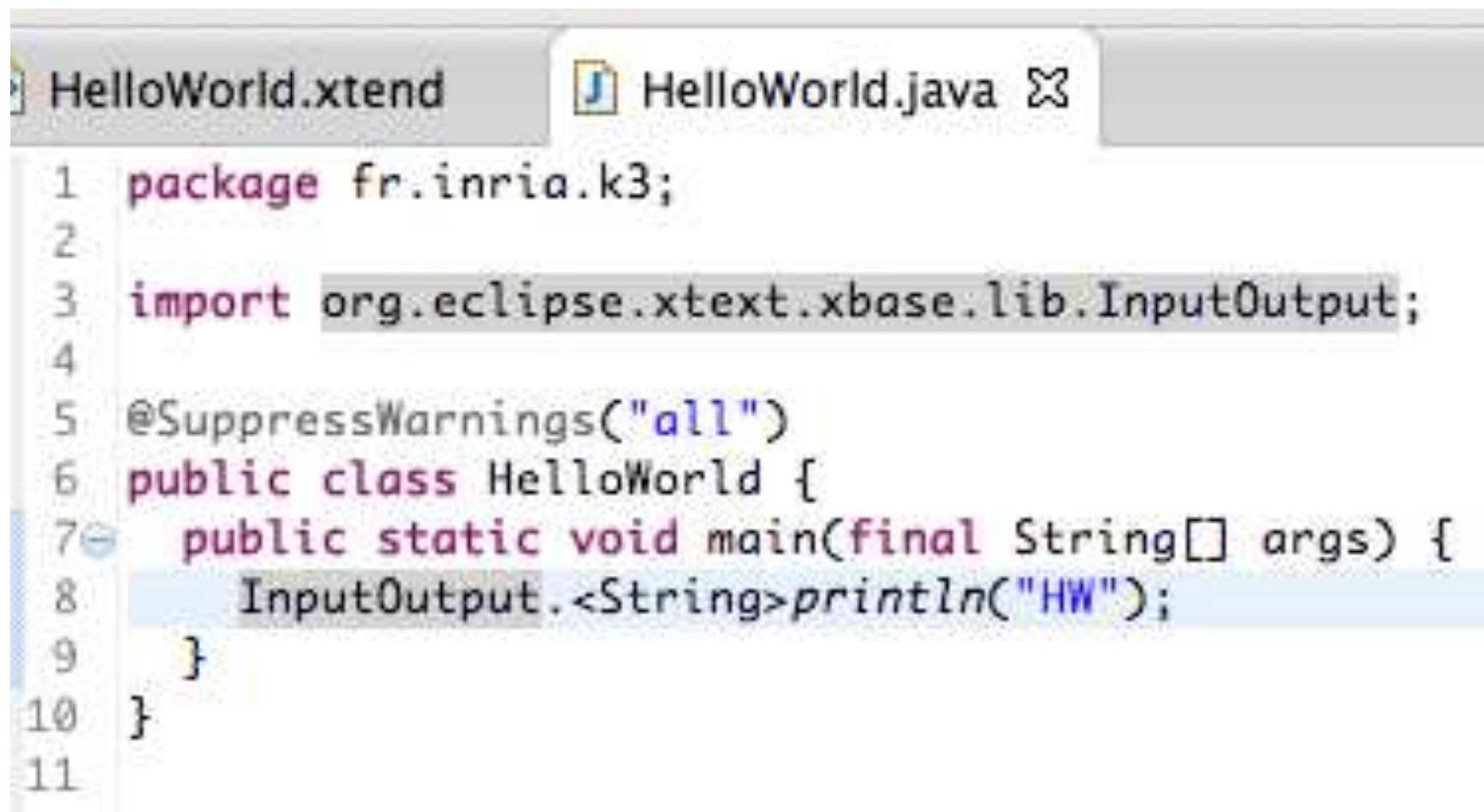
```
<h1>Exemple de page JSP</h1>
<%-- Impression de variables --%>
<p>Au moment de l'exécution de ce script, nous sommes le <%= date %>. </p>
<p>Cette page a été affichée <%= nombreVisites %> fois !</p>
</body>
</html>
```

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



- Xtend: seamless integration into a general purpose language

Xtend to Java



```
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 }
```

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}
```



```
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;
    }
}
```

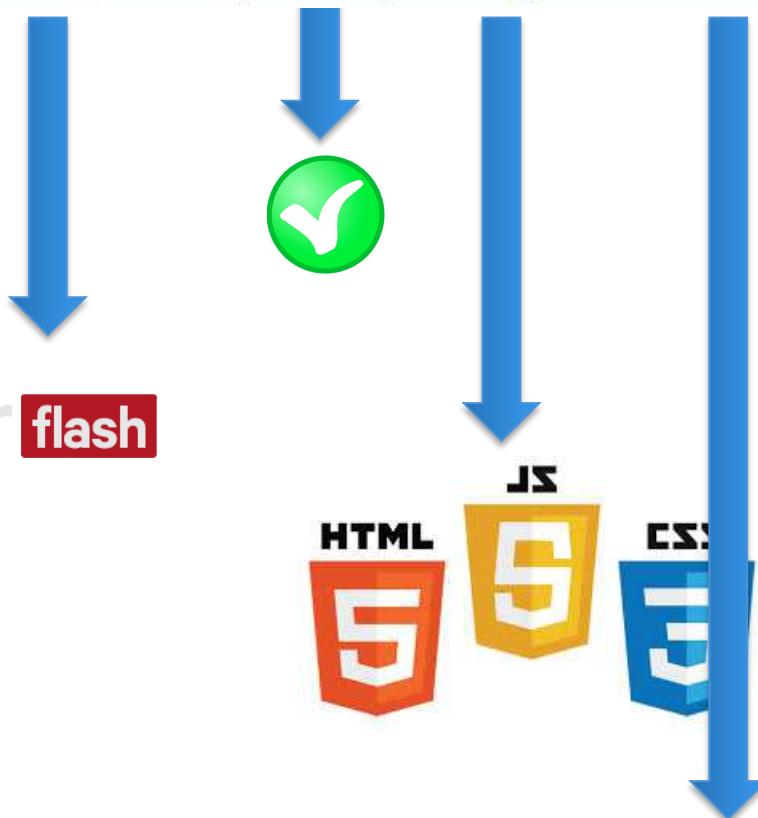
Xtend/Xtext

Back to our scenarios

foo1.videoogen

```
mandatory videooseq v1 "https://www.youtube.com/watch?v=PJNi1uYhV5w"
optional videooseq v2 "v2Folder/v2.mp4"
alternatives v3 {
    videooseq v31 "v3/seq1.mp4"
    videooseq v32 "v3/seq1.mp4"
    videooseq v33 "v3/seq1.mp4"
}

alternatives v4 {
    videooseq v41 "v4/seq1.mp4"
    videooseq v42 "v4/seq1.mp4"
}
mandatory videooseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```



flowplayer **flash**



 FFmpeg



18, 167, 899



Refactoring

```

def loadVideoGenerator(URI uri) {
    new VideoGenStandaloneSetupGenerated().createInjectorAndDoEMFRegistration()
    var res = new ResourceSetImpl().getResource(uri, true);
    res.contents.get(0) as VideoGeneratorModel
}

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

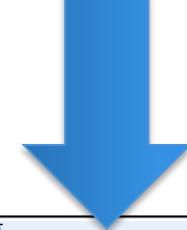
@Test
def test1() {
    // loading
    var videoGen = loadVideoGenerator(URI.createURI("foo2.videogen"))
    assertNotNull(videoGen)
    assertEquals(3, videoGen.videoseqs.size)
    // MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
    videoGen.videoseqs.forEach[videoseq] {
        if (videoseq instanceof MandatoryVideoSeq) {
            val desc = (videoseq as MandatoryVideoSeq).description
            if(desc.videoid.isNullOrEmpty) desc.videoid = genID()
        }
        else if (videoseq instanceof OptionalVideoSeq) {
            val desc = (videoseq as OptionalVideoSeq).description
            if(desc.videoid.isNullOrEmpty) desc.videoid = genID()
        }
        else {
            val altvid = (videoseq as AlternativeVideoSeq)
            if(altvid.videoid.isNullOrEmpty) altvid.videoid = genID()
            for (vdesc : altvid.videodescs) {
                if(vdesc.videoid.isNullOrEmpty) vdesc.videoid = genID()
            }
        }
    }
    // serializing
    saveVideoGenerator(URI.createURI("foo2bis.xmi"), videoGen)
    saveVideoGenerator(URI.createURI("foo2bis.videogen"), videoGen)
}

```

```

VideoGen {
    mandatory videoseq "V1/v1.mp4"
    optional videoseq "v2folder/v2.mp4" {
        probability 25
    }
    alternatives vid3 {
        videoseq "v3/seq1.mp4"
        videoseq vid31 "v3/seq2.mp4"
        videoseq vid32 "v3/seq3.mp4"
    }
    alternatives vid4 {
        videoseq vid41 "v4/seq1.mp4"
        videoseq vid42 "v4/seq2.mp4"
    }
    mandatory videoseq vid5 "v5.mp4"
    optional videoseq vid8 "v8.avi"
    alternatives vid9 {
        videoseq vid81 "V81.avi"
    }
}

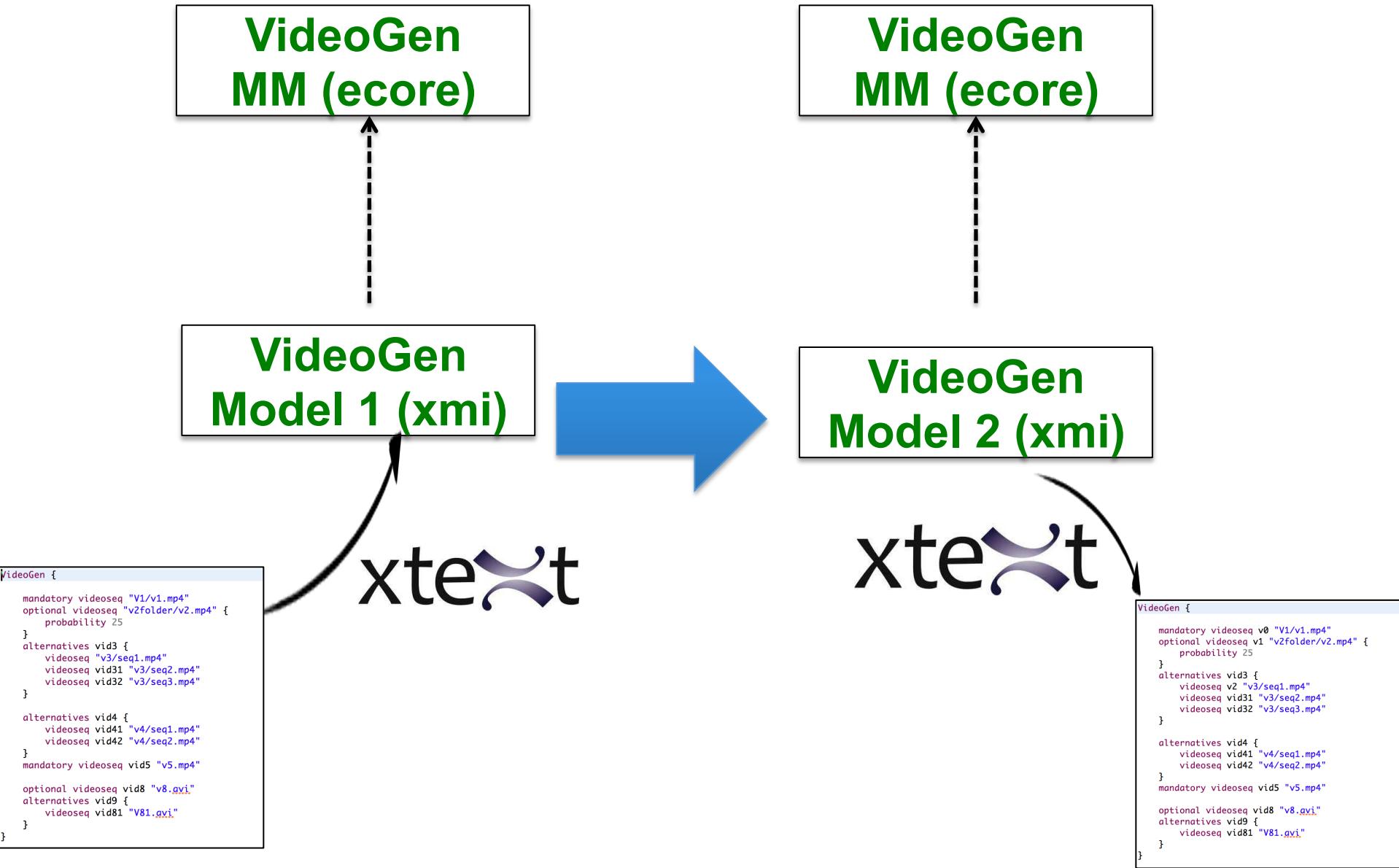
```



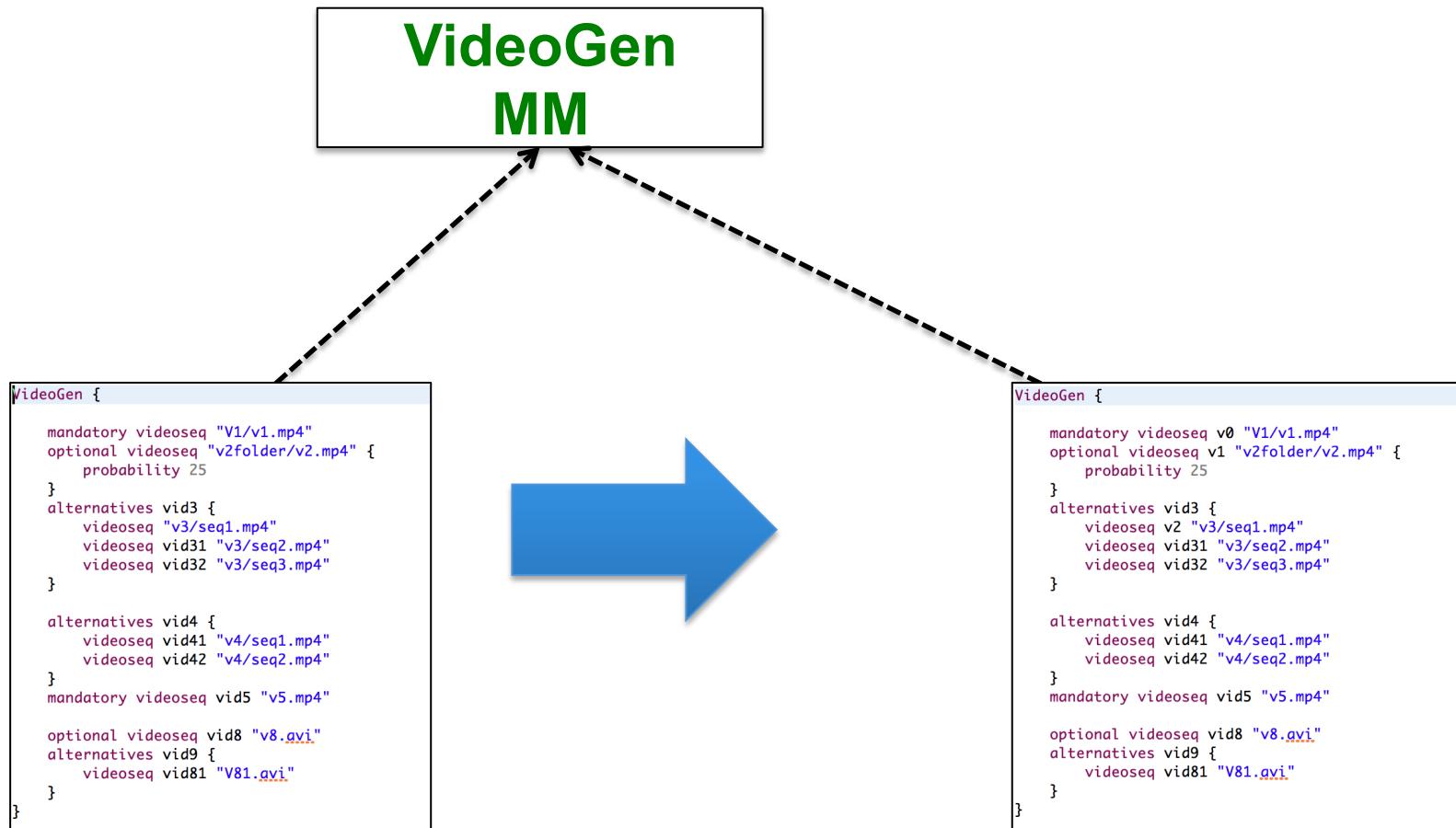
```

VideoGen {
    mandatory videoseq v0 "V1/v1.mp4"
    optional videoseq v1 "v2folder/v2.mp4" {
        probability 25
    }
    alternatives vid3 {
        videoseq v2 "v3/seq1.mp4"
        videoseq vid31 "v3/seq2.mp4"
        videoseq vid32 "v3/seq3.mp4"
    }
    alternatives vid4 {
        videoseq vid41 "v4/seq1.mp4"
        videoseq vid42 "v4/seq2.mp4"
    }
    mandatory videoseq vid5 "v5.mp4"
    optional videoseq vid8 "v8.avi"
    alternatives vid9 {
        videoseq vid81 "V81.avi"
    }
}

```

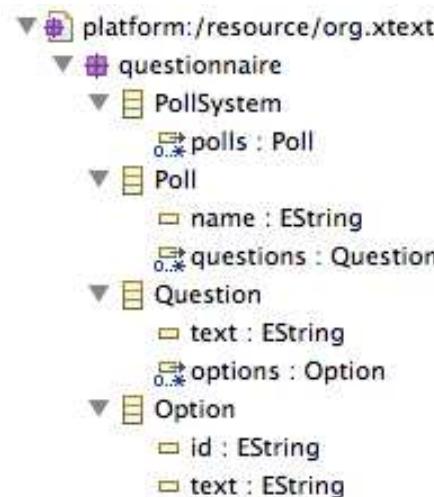


Endogeneous Transformation





```
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)  
}
```



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 }
```

```

@Test
def test2() {

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

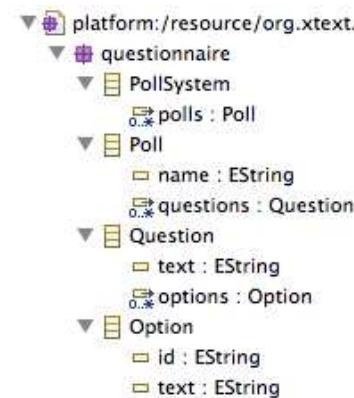
    // MODEL MANAGEMENT (ANALYSIS, TRANSFORMATION)
    var html = toPolls(pollS.polls)
    assertNotNull(html)

    // 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>
}

```



poll1

What is A ?

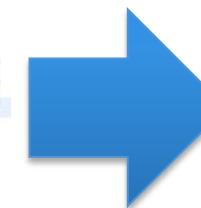
- B
- C
- D

foo1.q

```

class 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"
        }
    }
}

```



poll2

What is D ?

- E
- F

Facilities to create objects in a programmatic way



```
platform:/resource/org.xtext.e
  questionnaire
    PollSystem
      polls : Poll
    Poll
      name : EString
      questions : Question
    Question
      text : EString
      options : Option
    Option
      id : EString
      text : EString
```



Ecore Model

EPackage
EClass
EAttribute
EReference

Code generation



Java Code

Package
Class
Attribute
Reference

```
@Test
def test2() {

  var pollSystem = QuestionnaireFactory.eINSTANCE.createPollSystem ;
  var p1 = QuestionnaireFactory.eINSTANCE.createPoll() ;
  p1.setName("p1");
  pollSystem.polls.add(p1)
  //
```

Lab Sessions

Overview

```
foo1.videogen &gt;
mandatory videoseq v1 "https://www.youtube.com/watch?v=PjNi1uYhV5w"
optional videoseq v2 "v2folder/v2.mp4"
alternatives v3 {
    videoseq v31 "v3/seq1.mp4"
    videoseq v32 "v3/seq1.mp4"
    videoseq v33 "v3/seq1.mp4"
}

alternatives v4 {
    videoseq v41 "v4/seq1.mp4"
    videoseq v42 "v4/seq1.mp4"
}
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```

model-to-model

**playlist
metamodel**

playlist model

model-to-text

flowplayer **flash**

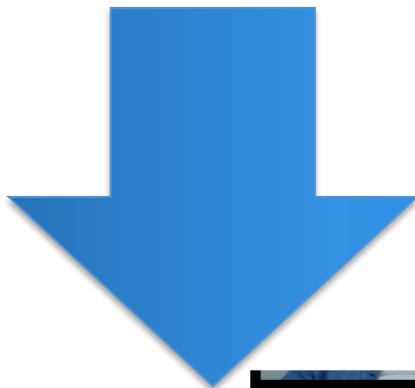


FFmpeg

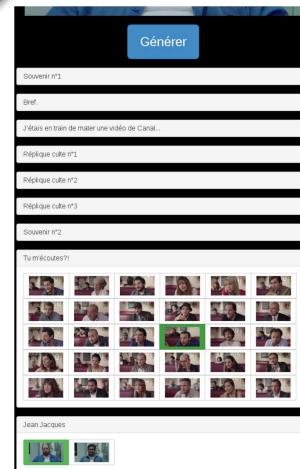
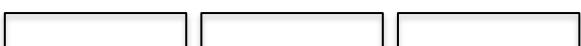
foo1.videogen

```
mandatory videoseq v1 "https://www.youtube.com/watch?v=PjNi1uYhV5w"
optional videoseq v2 "v2Folder/v2.mp4"
alternatives v3 {
    videoseq v31 "v3/seq1.mp4"
    videoseq v32 "v3/seq1.mp4"
    videoseq v33 "v3/seq1.mp4"
}

alternatives v4 {
    videoseq v41 "v4/seq1.mp4"
    videoseq v42 "v4/seq1.mp4"
}
mandatory videoseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```



Thumbnails (vignettes) of each video sequence (e.g., PGN format)



model-to-*
 FFmpeg



foo1.videoogen

```
mandatory videooseq v1 "https://www.youtube.com/watch?v=PJNi1uYhV5w"
optional videooseq v2 "v2folder/v2.mp4"
alternatives v3 {
    videooseq v31 "v3/seq1.mp4"
    videooseq v32 "v3/seq1.mp4"
    videooseq v33 "v3/seq1.mp4"
}

alternatives v4 {
    videooseq v41 "v4/seq1.mp4"
    videooseq v42 "v4/seq1.mp4"
}
mandatory videooseq v5 "https://www.youtube.com/watch?v=ezKx-S0LiNQ"
```



Website/online

- Random generation
- Configurator
- Game
- ...



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/>



Xtext.Xtext?