Karlsruhe Institute of Technology

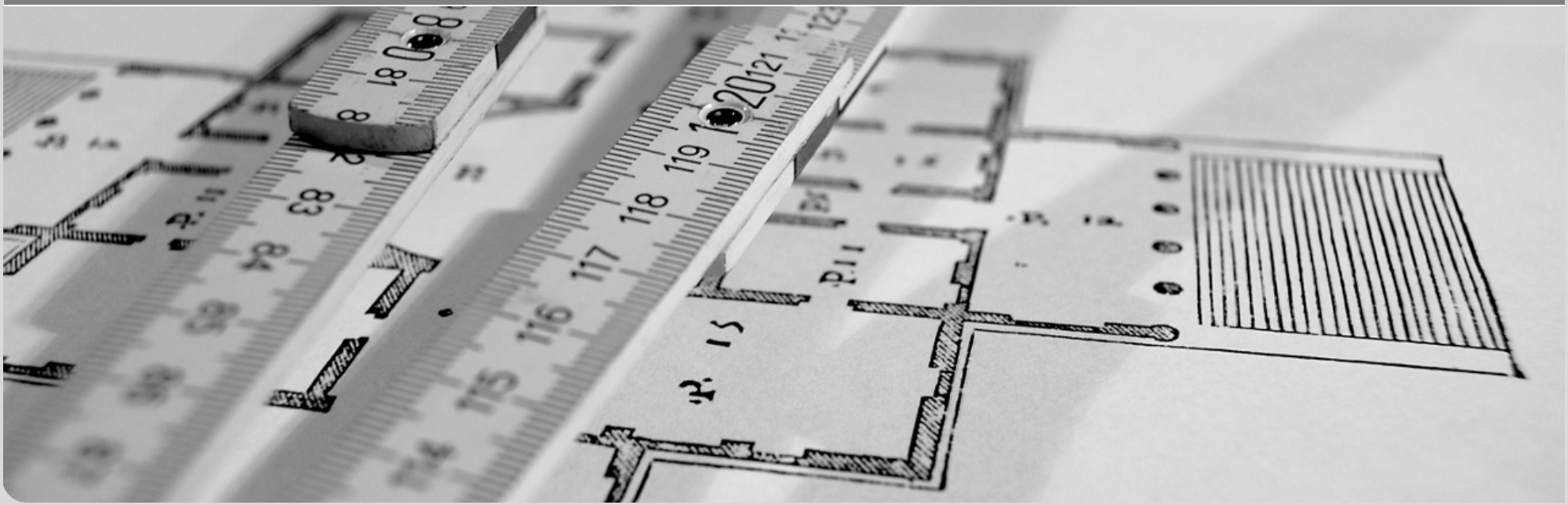
Software Design and Quality

View-based Model-driven Software Development with ModelJoin

Arbeitskreistreffen AK-MDSD, Paderborn, Germany

Erik Burger, Jörg Henß, Steffen Kruse, Martin Küster | 02.07.2012

CHAIR FOR SOFTWARE DESIGN AND QUALITY



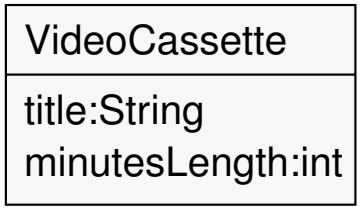
Outline

Motivation

Motivation


library


imdb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minutesLength:int

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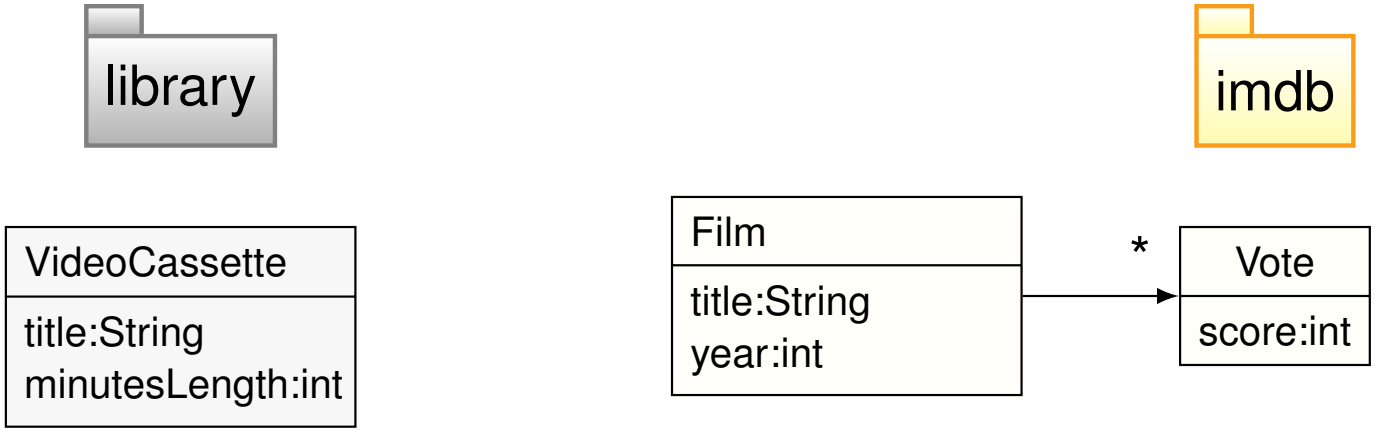
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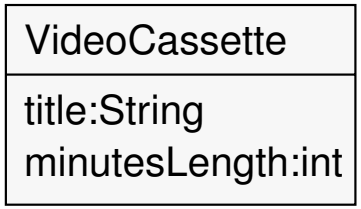
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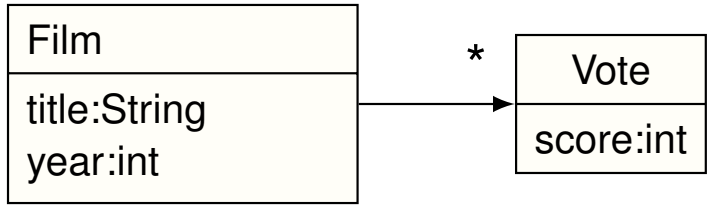
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year:int
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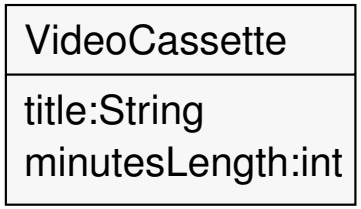
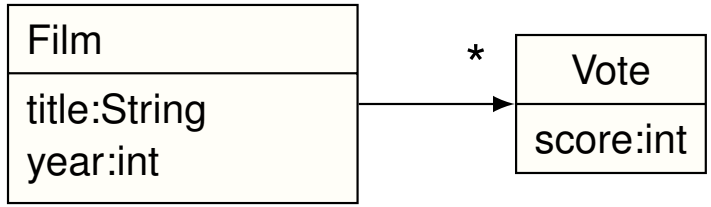
STAR TREK
FIRST CONTACT

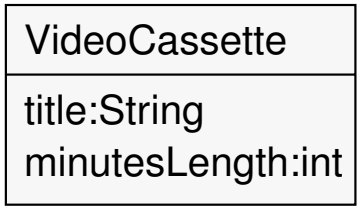
Motivation

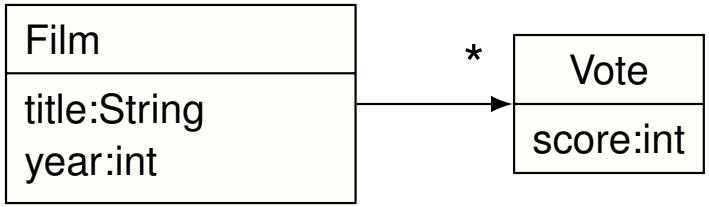




```
Star Trek 1:  6.3
Star Trek 7:  6.5
Star Trek 8:  7.5
```

Motivation





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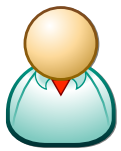
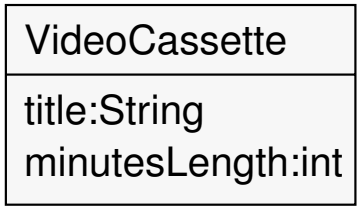
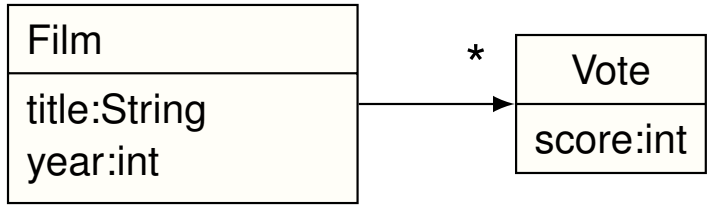


User A

User B

Motivation





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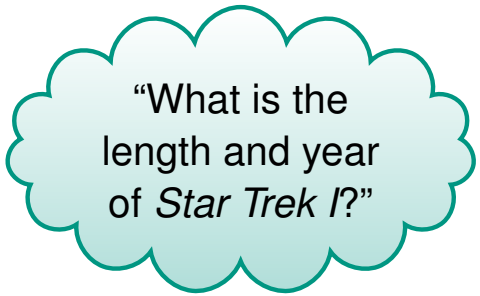
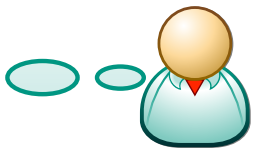
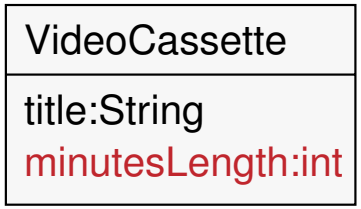


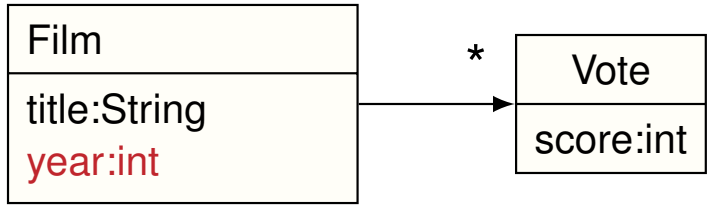


User A

User B

Motivation





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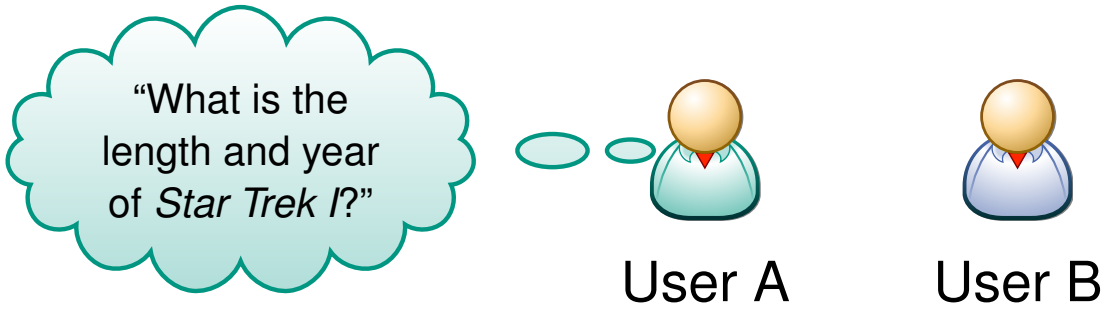

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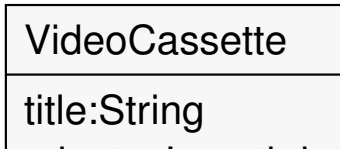

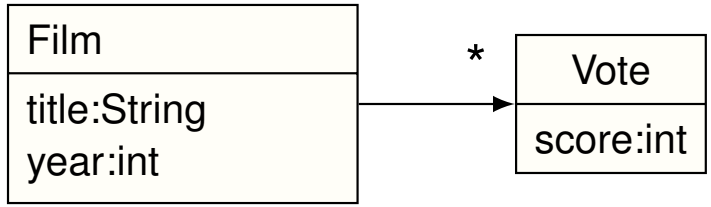

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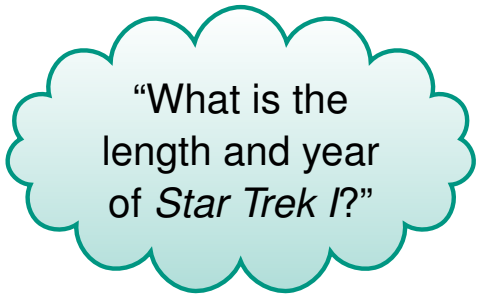
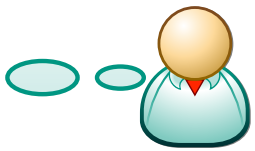
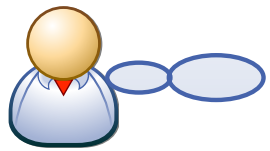




User A



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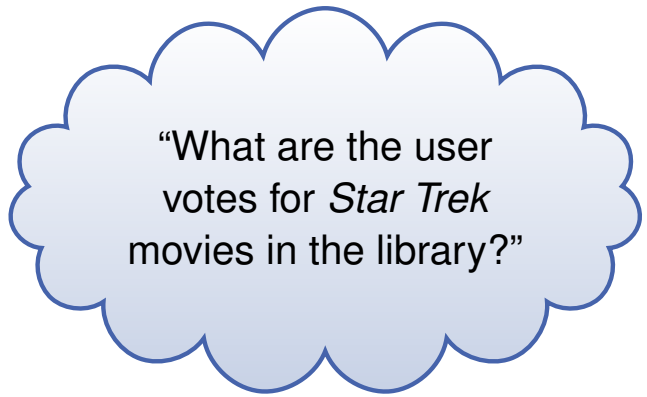

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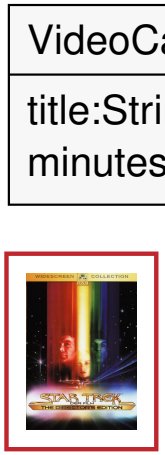

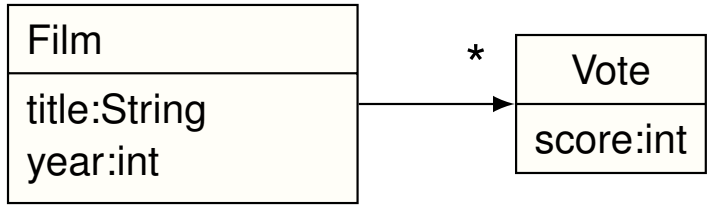

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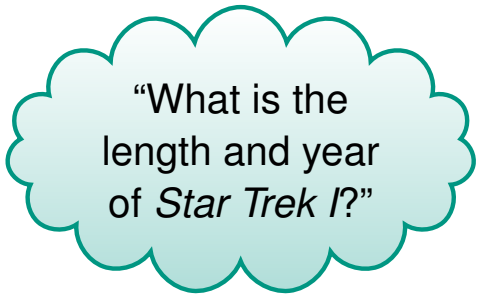

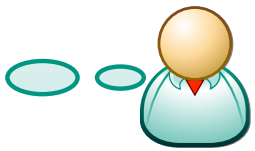

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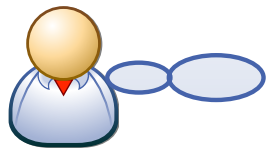

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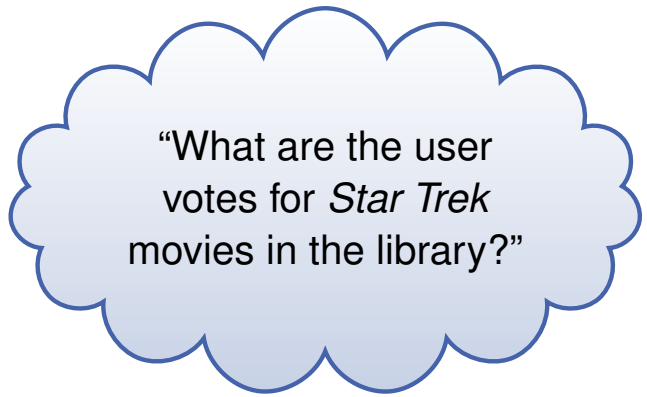

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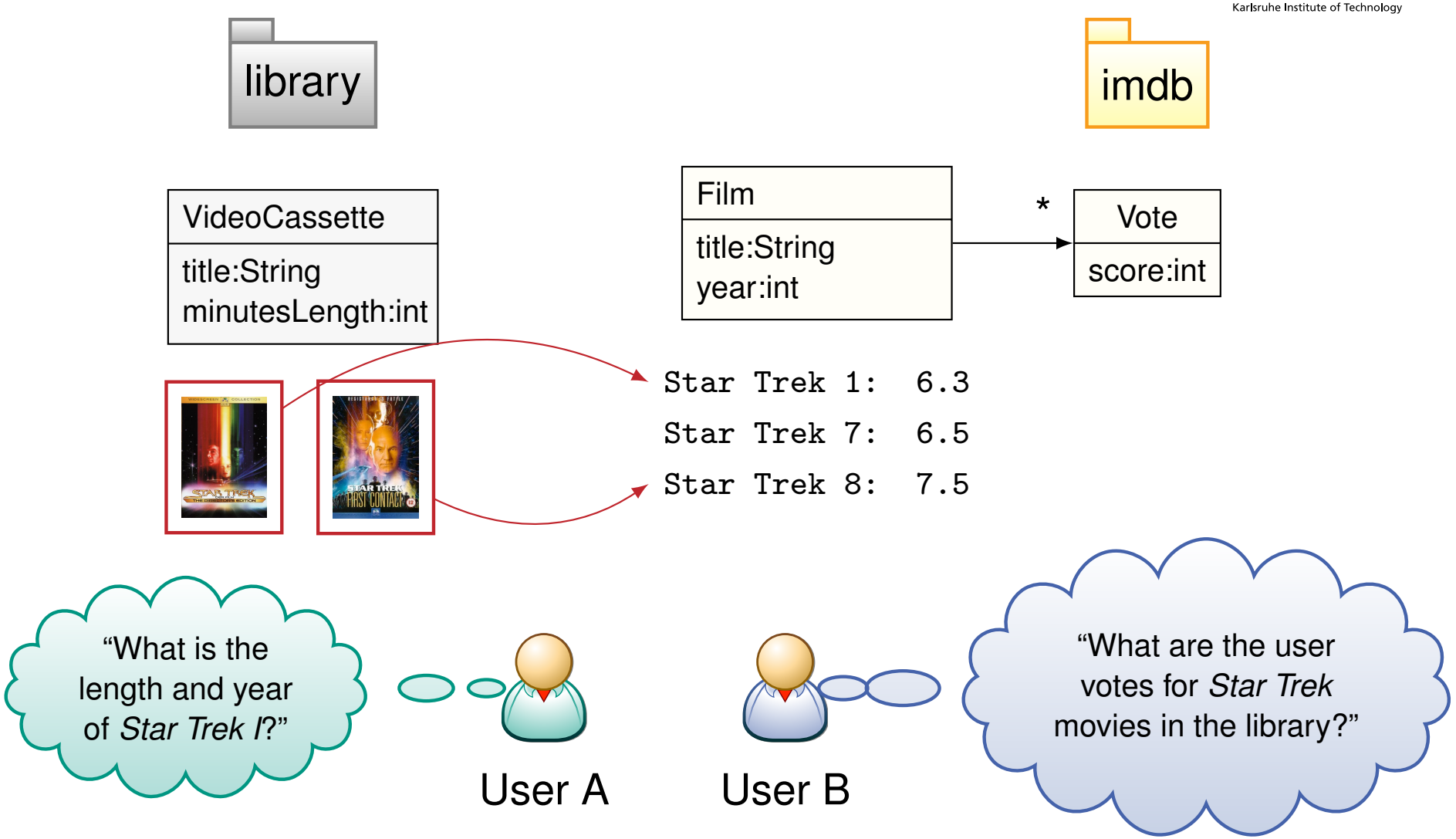
library
imdb
VideoCassette
title:String
minutesLength:int
Film
title:String
year:int
*
Vote
score:int
Star Trek 1: 6.3
Star Trek 7: 6.5
Star Trek 8: 7.5
"What is the length and year of *Star Trek I*?"
User A
User B
"What are the user votes for *Star Trek* movies in the library?"

Problem

Metamodel

- information spread across heterogeneous metamodels which are structurally different but share a semantic overlap
- metamodels are only loosely coupled

Instances

- matching of elements necessary
- information need based on properties of instance level

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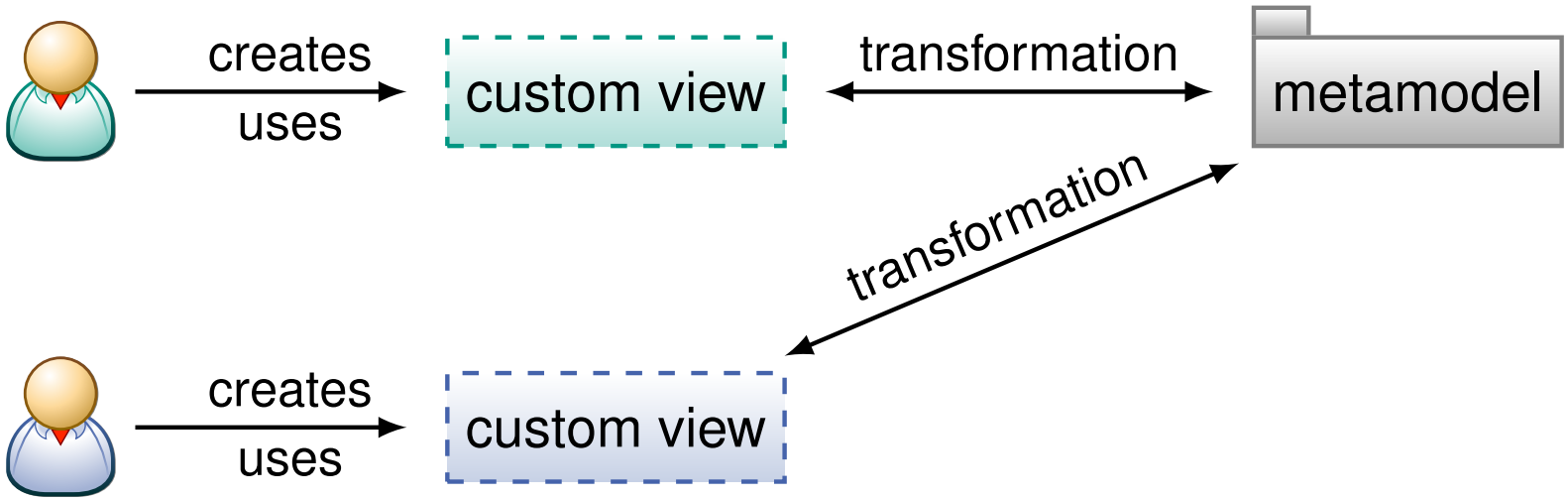
View-based MDSD

- custom *views* fulfill users' information need
- generation of on-demand views
- a view is also a model
- view generation = model transformation



Related Work

VideoCassette
title:String minutesLength:int

Film
title:String year:int

Related Work

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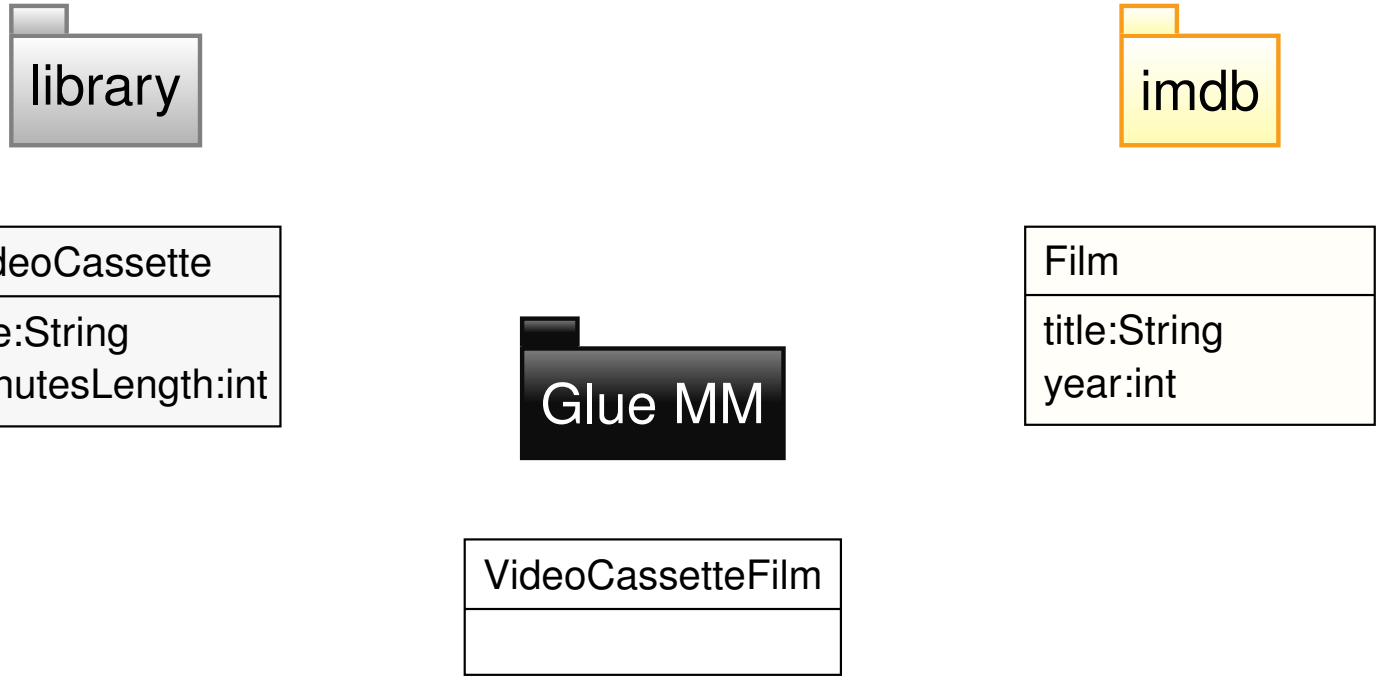

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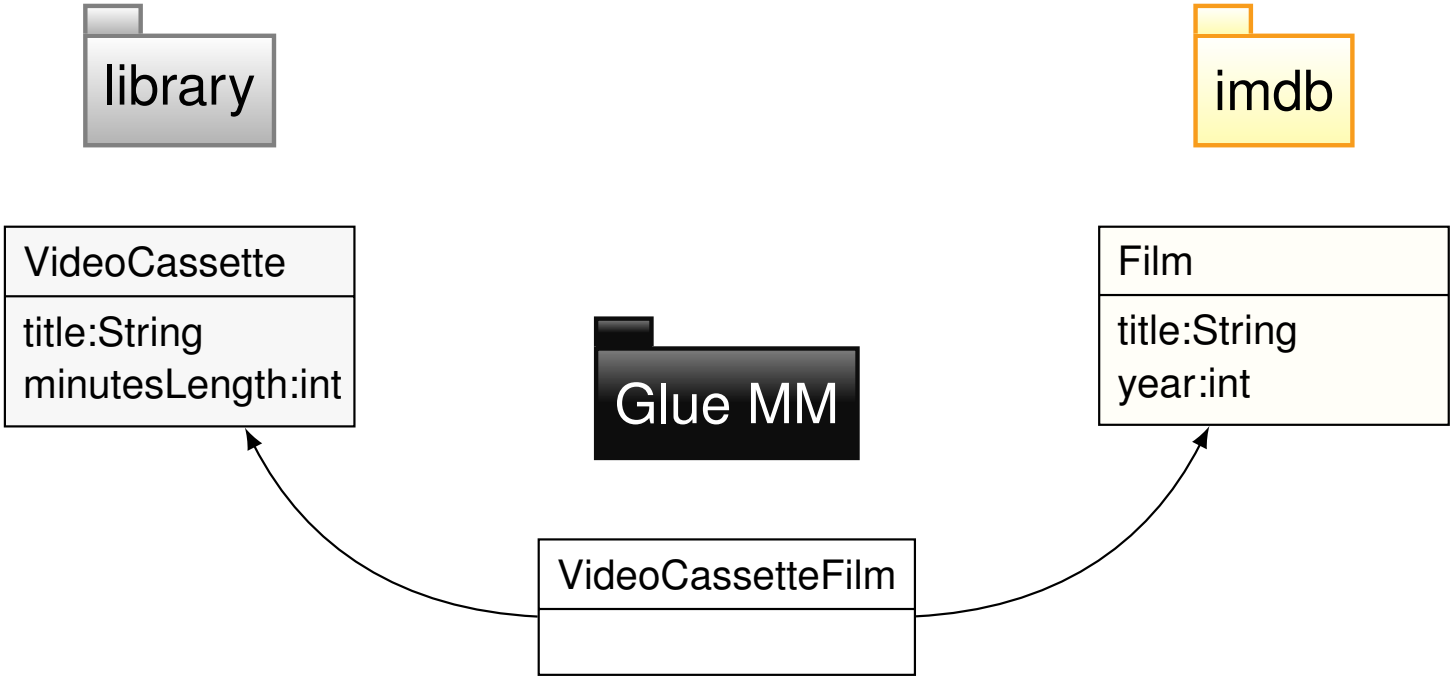

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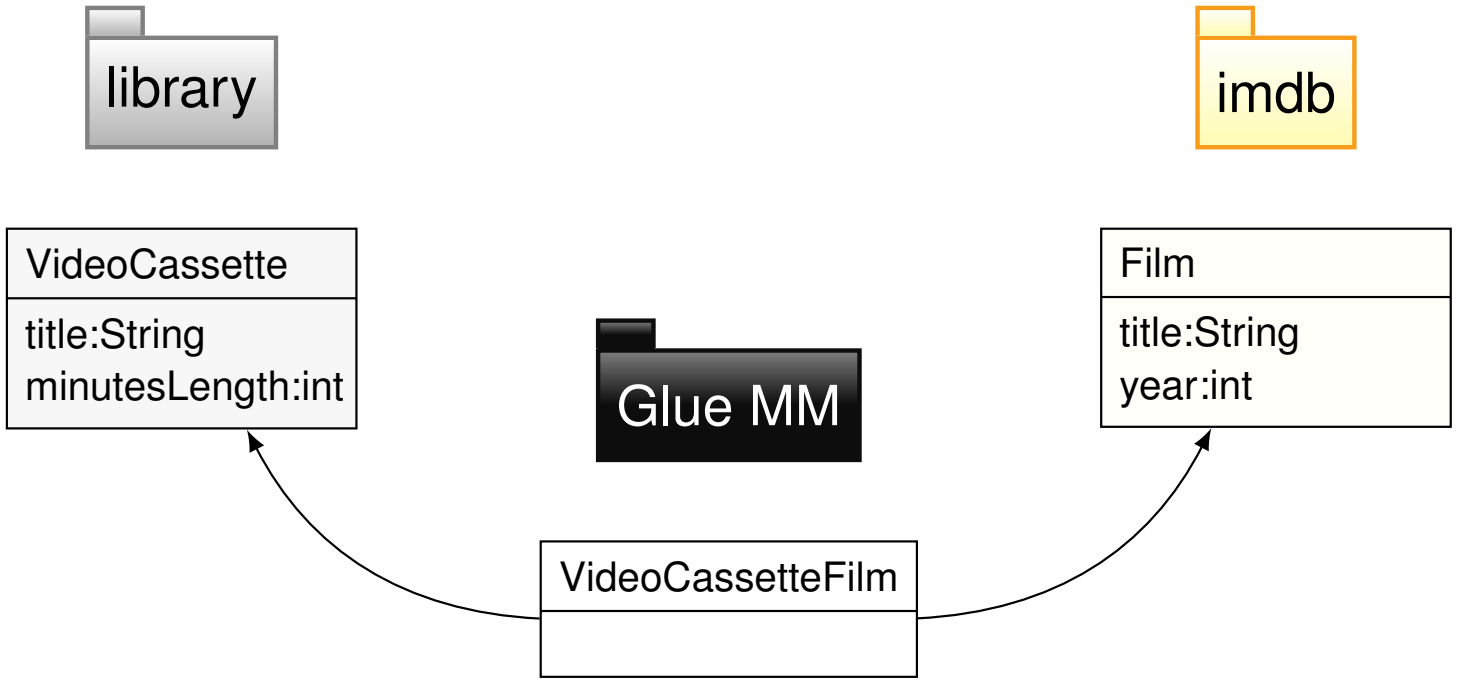
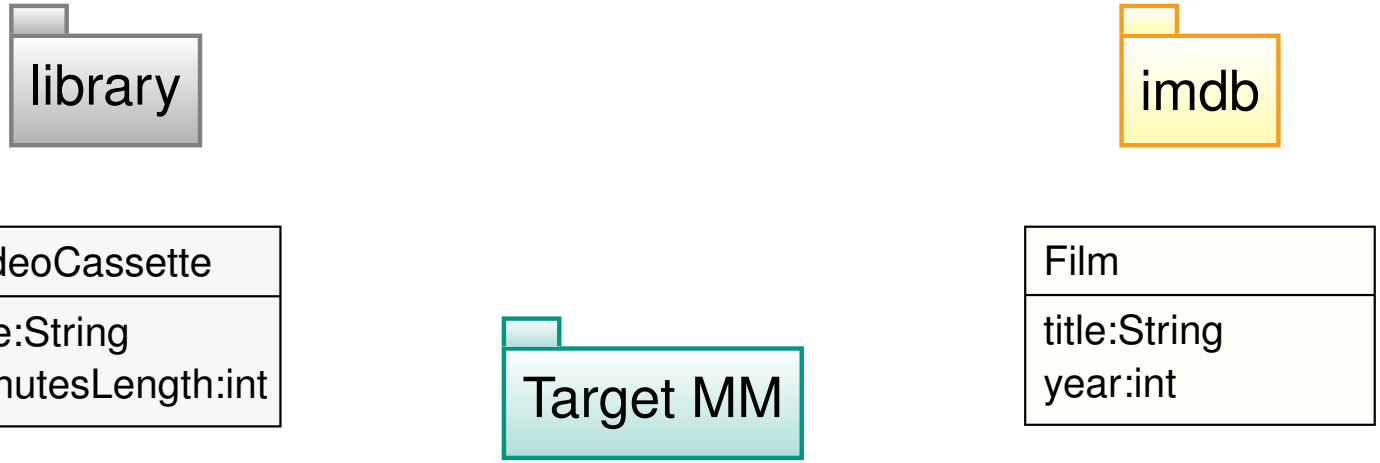


- definition of a glue/weaving model *(VirtualEMF, AMW)*
- matching of instances: weaving rules/heuristics *(EMFCompare, Epsilon)*

Related Work



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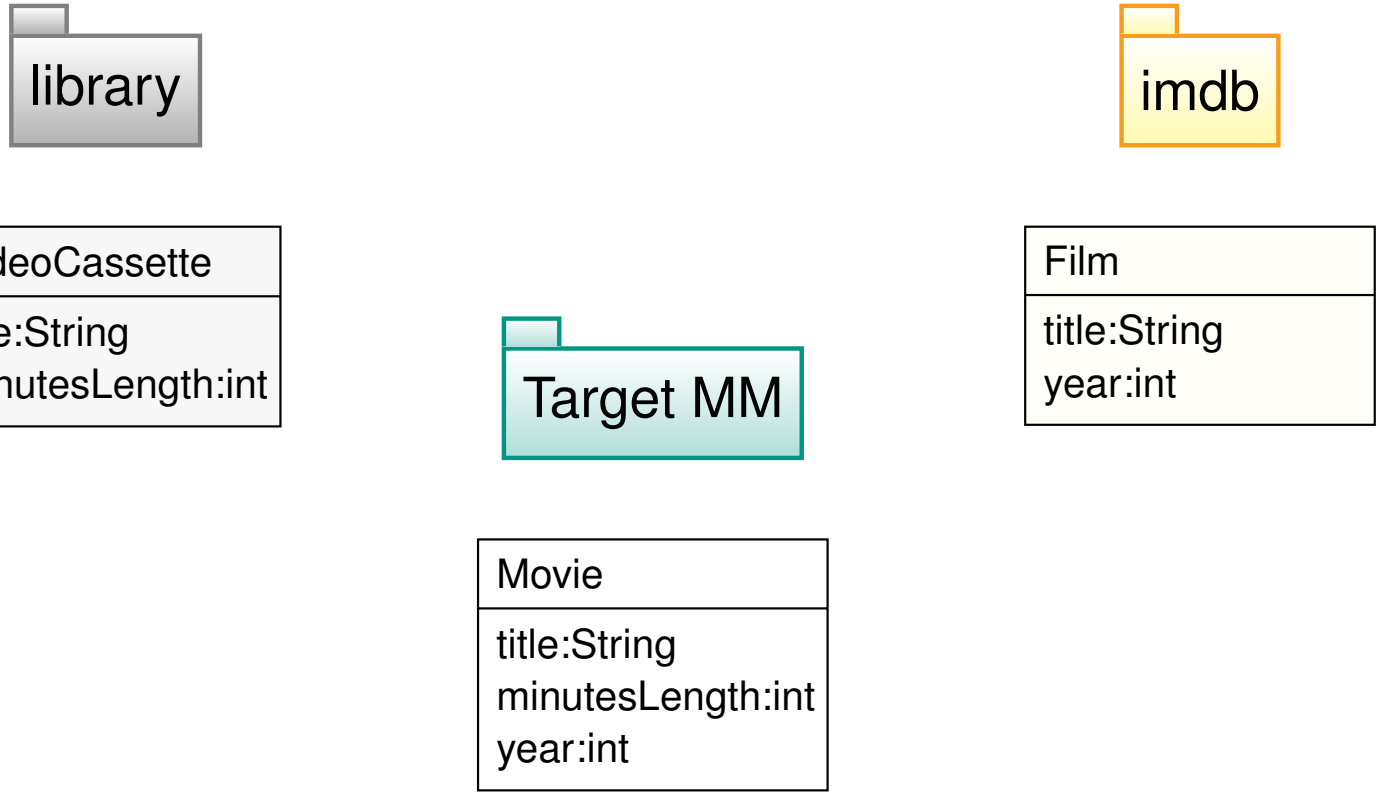

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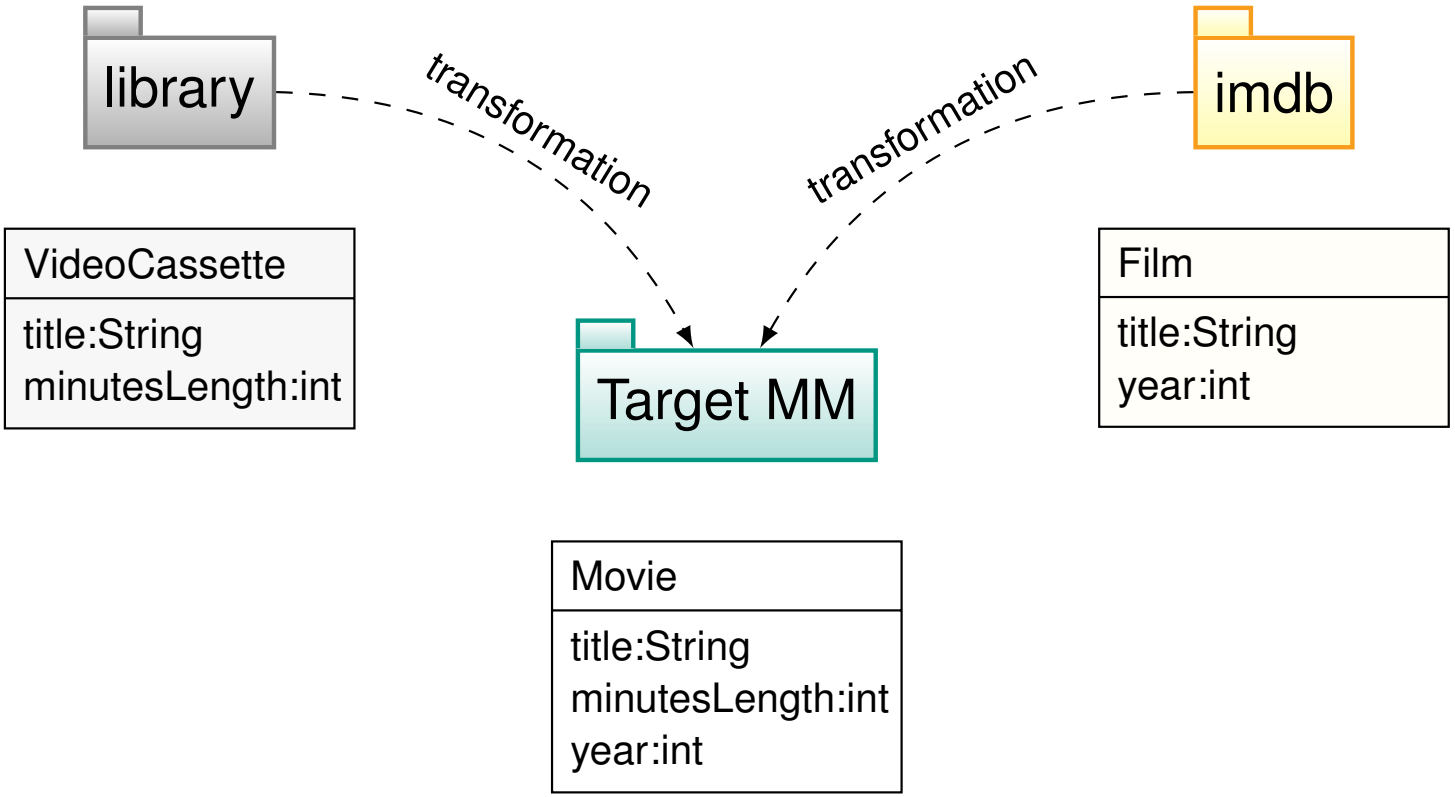

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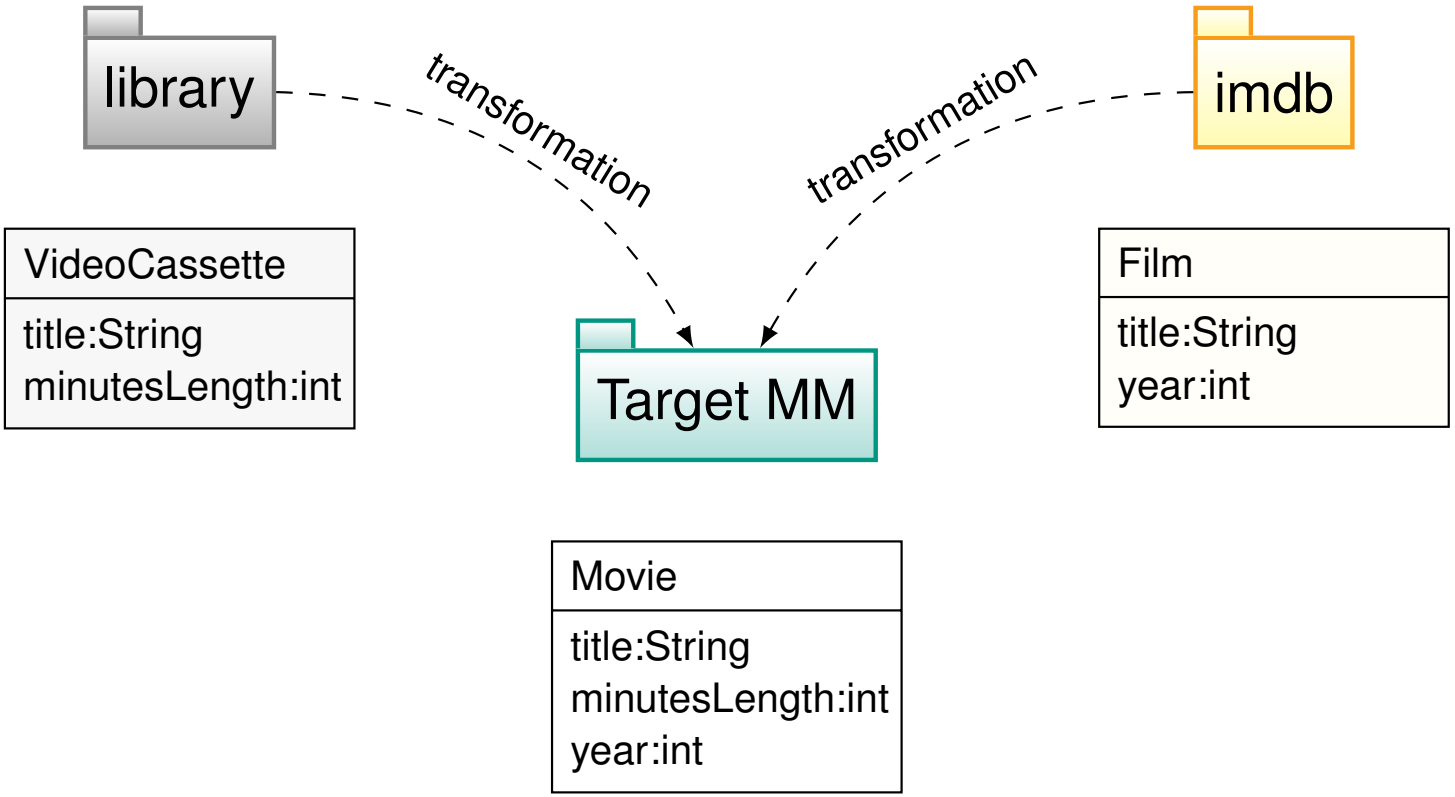

- create target/composition metamodel (or use fixed metamodel)
- define model transformation rules *(ModelBus, DuALLy)*

Outline

Idea

ModelJoin

- DSL with human-readable textual concrete syntax similar to SQL
- joining of instances of heterogeneous metamodels into custom views
- declarative definition of element and feature selection
- rapid definition and execution at “run-time”
- no need to define target metamodel or transformations manually
- non-intrusive approach (source metamodels and instances remain unchanged)

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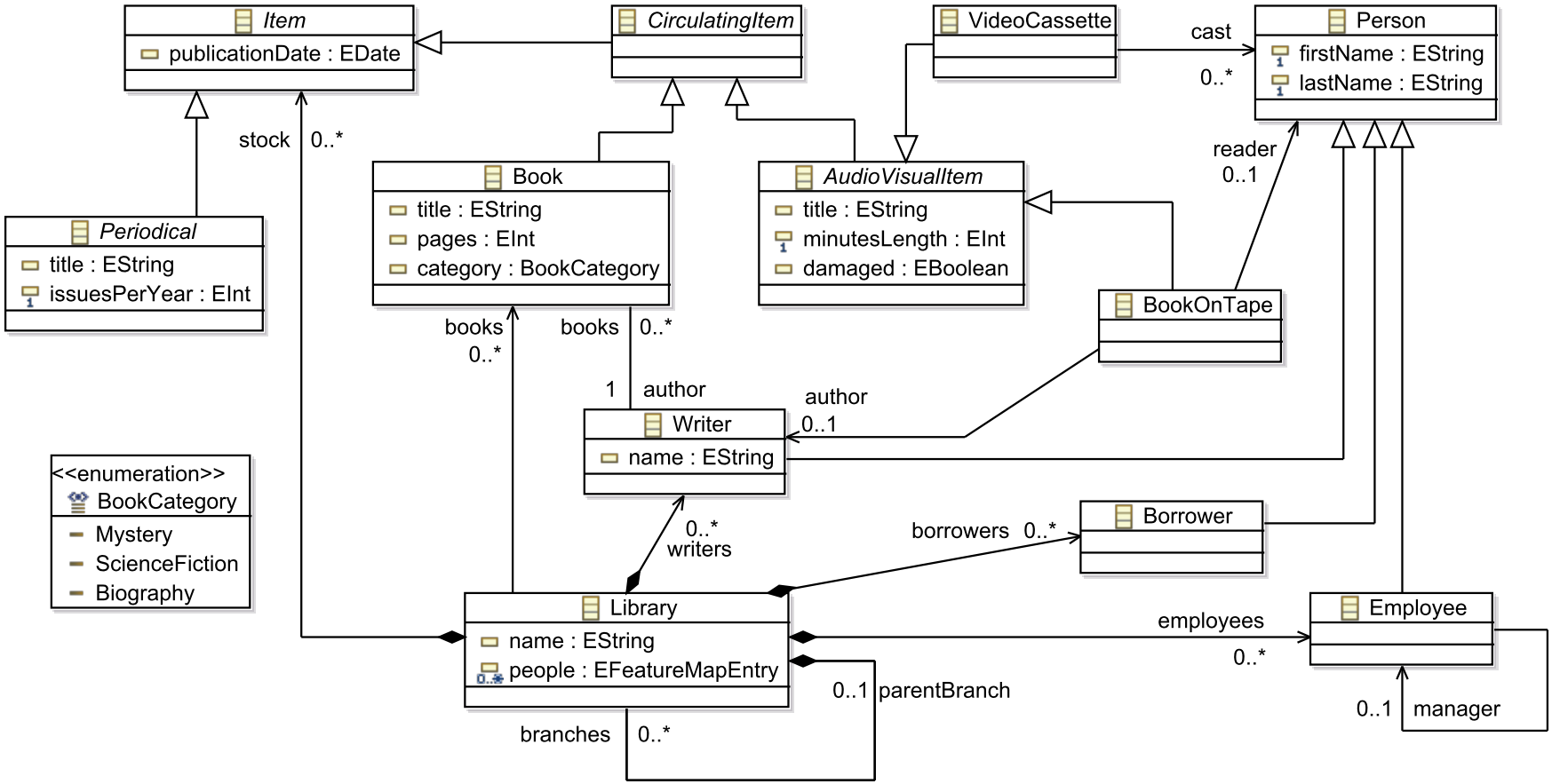
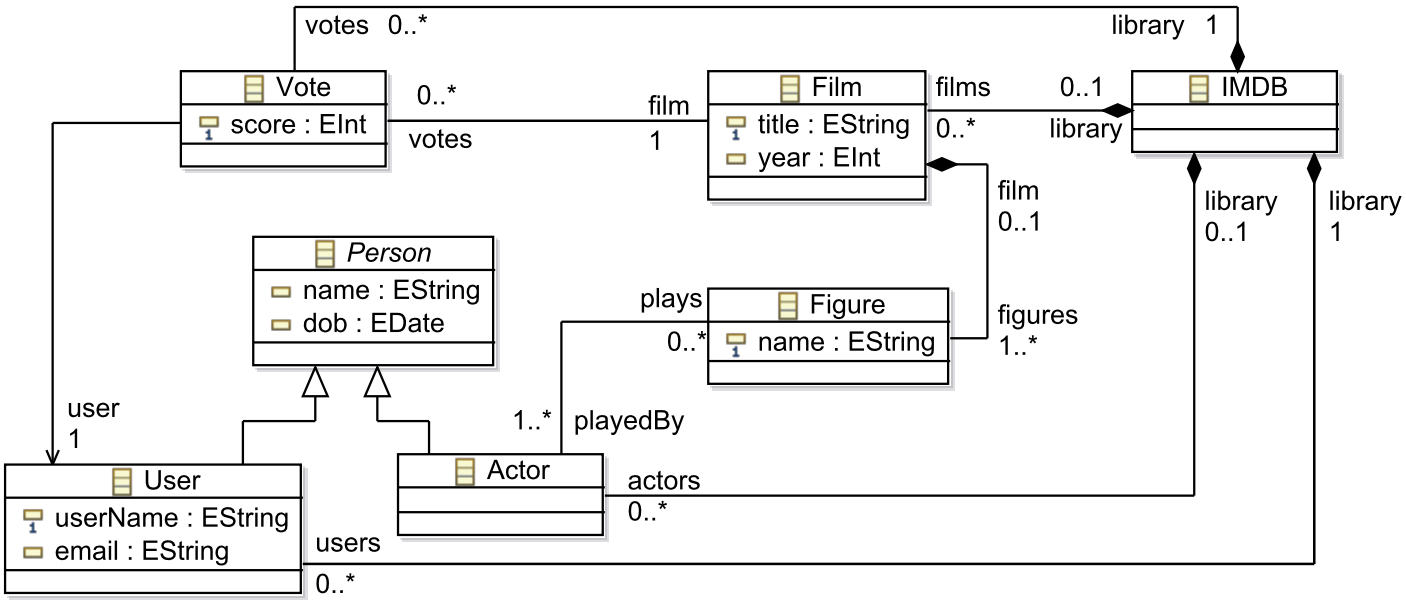
Example: Library Metamodel



Example: IMDB Metamodel



ModelJoin expression example

```
natural join imdb.Film with library.VideoCassette as jointarget.Movie
    with keep attributes imdb.Film.year
keep outgoing imdb.Film.votes as type jointarget.Vote
    with keep attributes imdb.Vote.score
keep supertype library.AudioVisualItem as type jointarget.MediaItem
    with keep attributes library.AudioVisualItem.minutesLength
where {{ library.Videocassette.cast->forAll (p |
     imdb.Film.figures->playedBy->exists (a | p.firstname.concat("␣")
     .concat(p.lastName) == a.name)) }}
```

ModelJoin expression example

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```

The ModelJoin DSL

- declarative approach
- a ModelJoin expression defines
  - the selection of elements in the target model
  - the layout of the target metamodel
- operators similar to SQL:
  - `join`
  - `keep` (Projection)
  - `where` (Selection)

Operators: Join

Natural Join

```
natural join imdb.Film with library.VideoCassette as jointarget.Movie
```

Operators: Join

Natural Join

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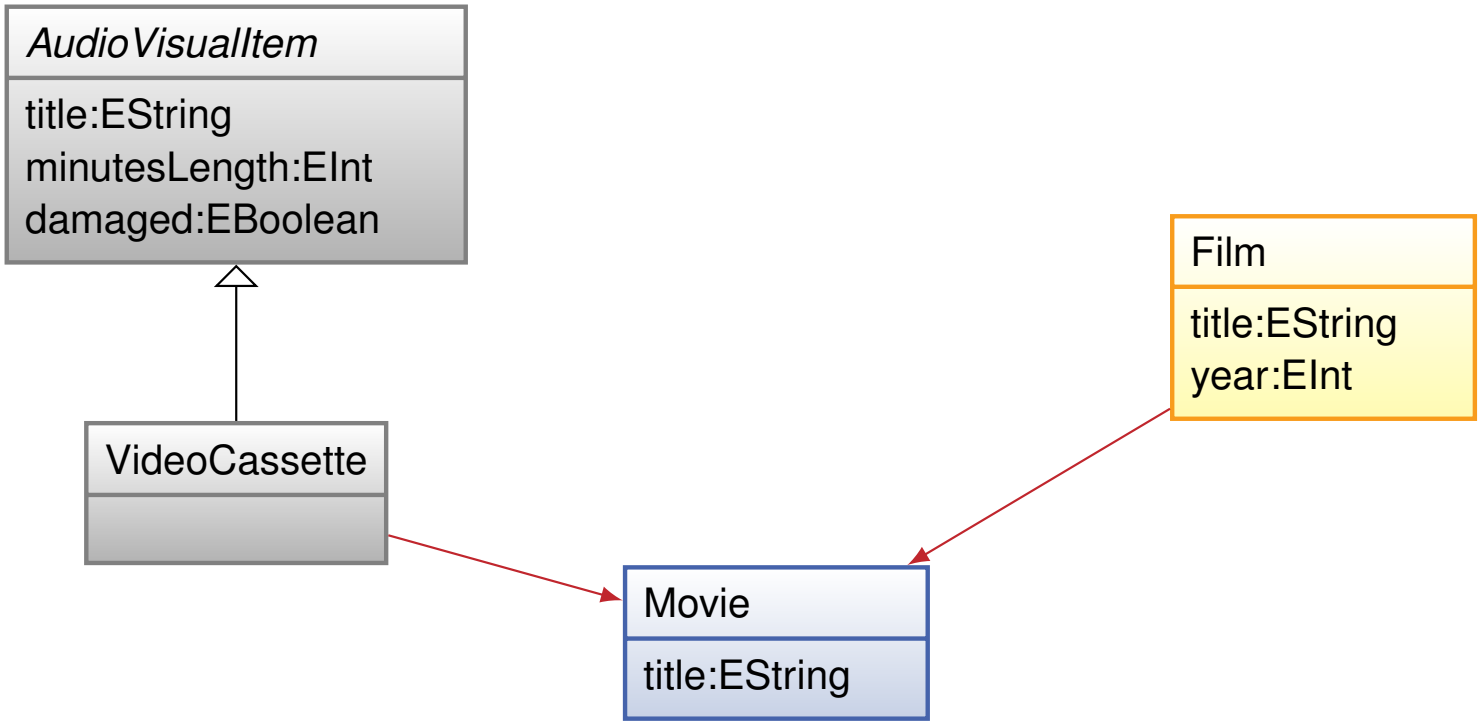

Operators: Join

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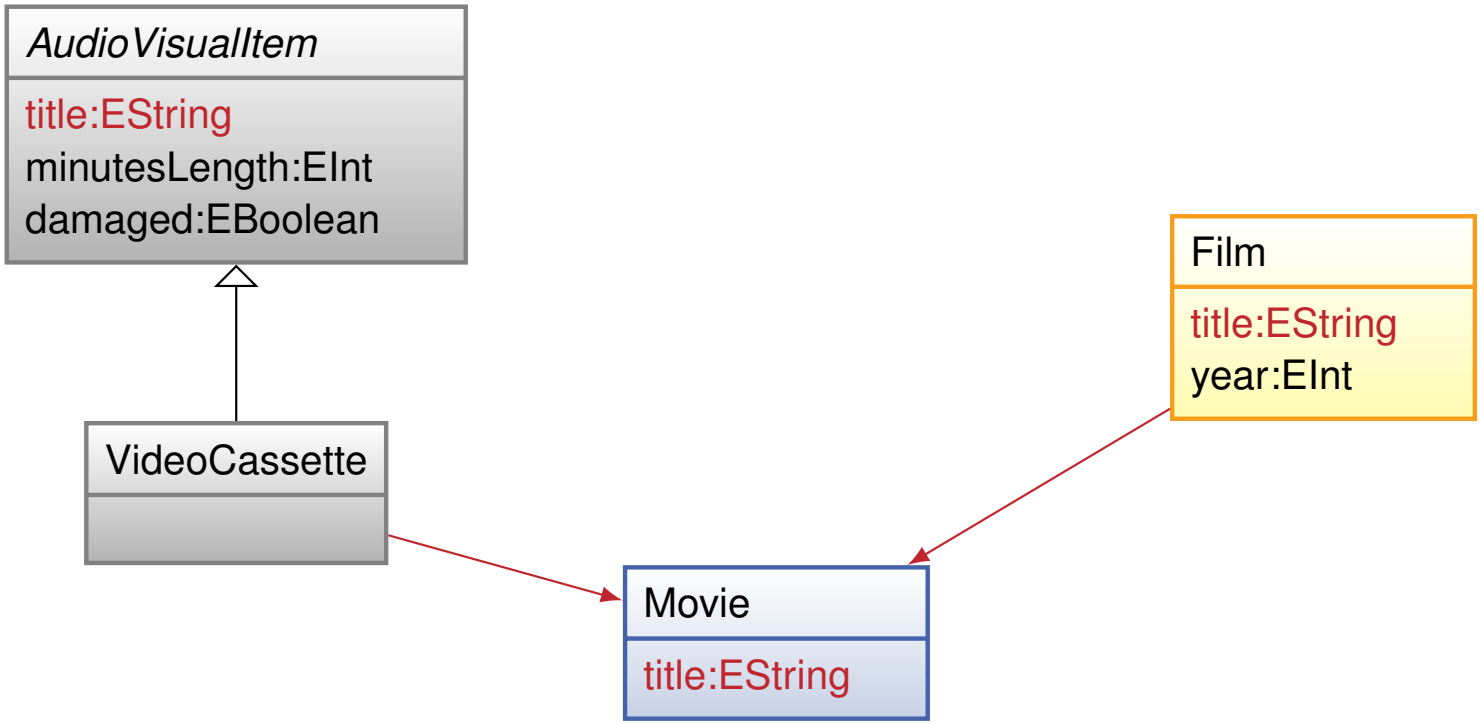


Operators: Join

Natural Join

```
natural join imdb.Film with library.VideoCassette as jointarget.Movie
```

st1:VideoCassette
title = “Star Trek I” minutesLength = 132

trek1:Film
title = “Star Trek I” year = 1979

trek7:Film
title = “Star Trek VII” year = 1994

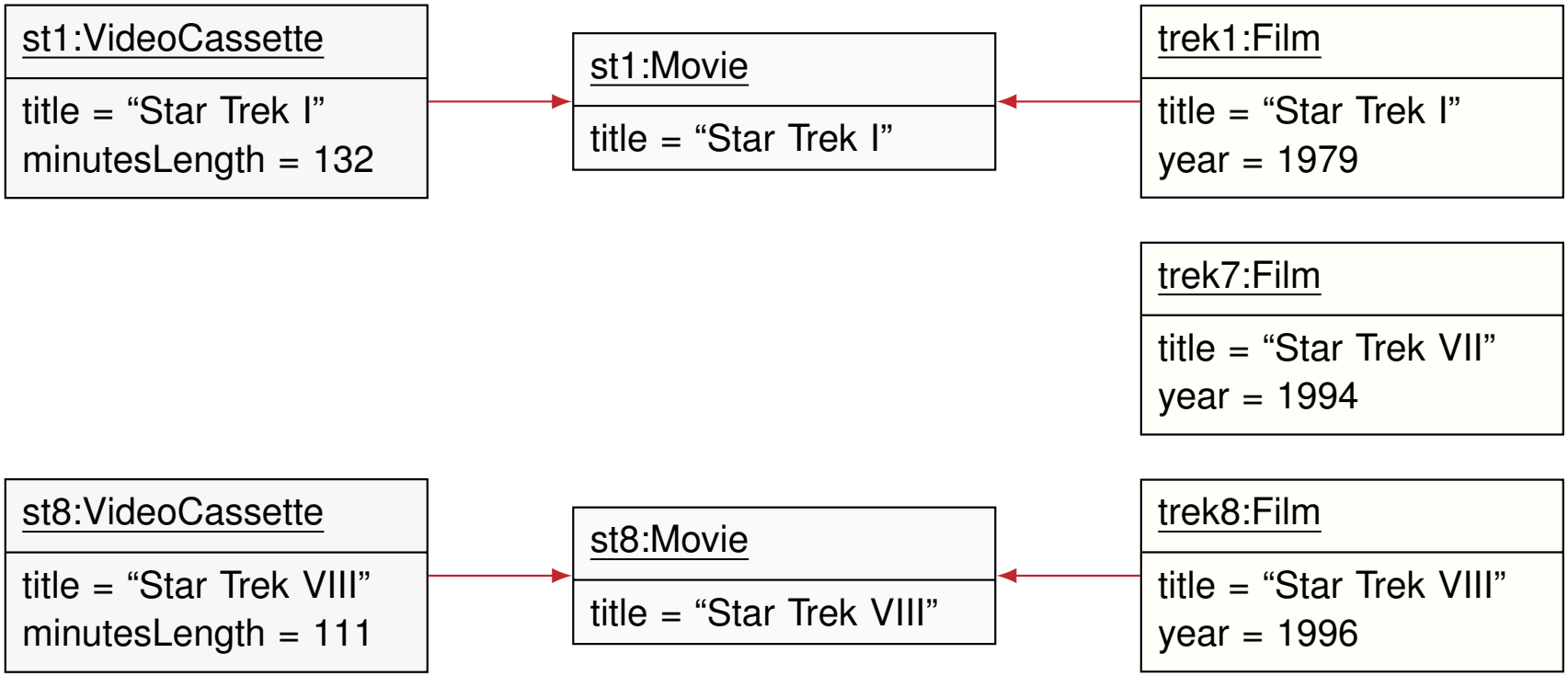
st8:VideoCassette
title = “Star Trek VIII” minutesLength = 111

trek8:Film
title = “Star Trek VIII” year = 1996

Operators: Join

Natural Join

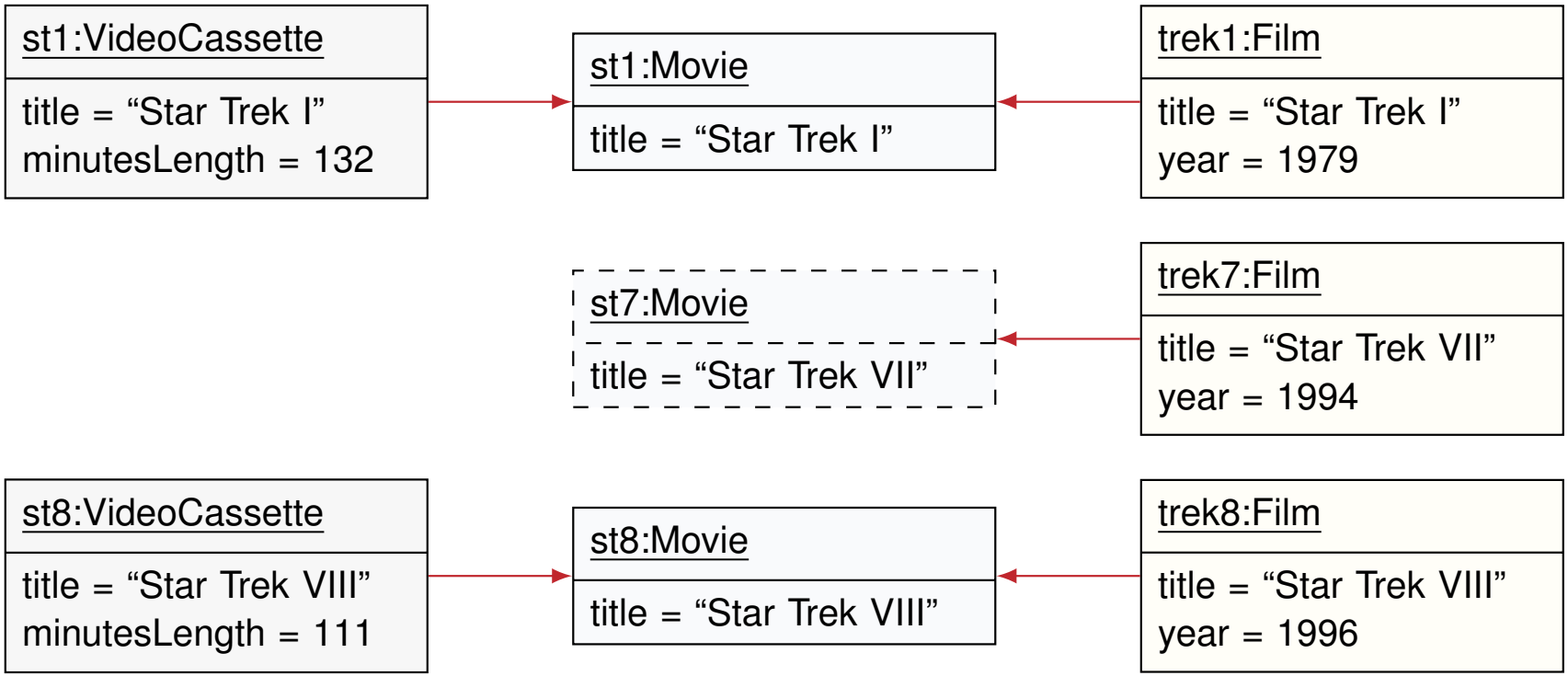
```
natural join imdb.Film with library.VideoCassette as jointarget.Movie
```



Operators: Join

Left outer Join

```
left outer join imdb.Film with library.VideoCassette as jointarget.Movie
```



Join Operator: Notes

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Operators: Keep

Keep Attributes

```
with keep attributes imdb.Film.year
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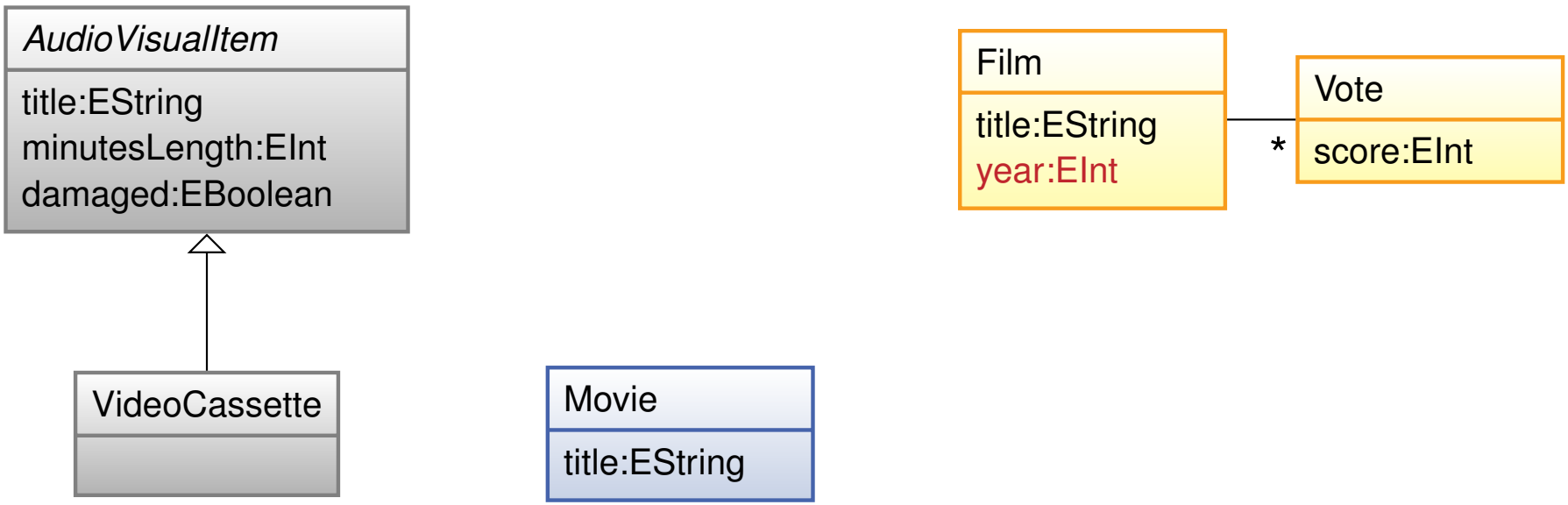

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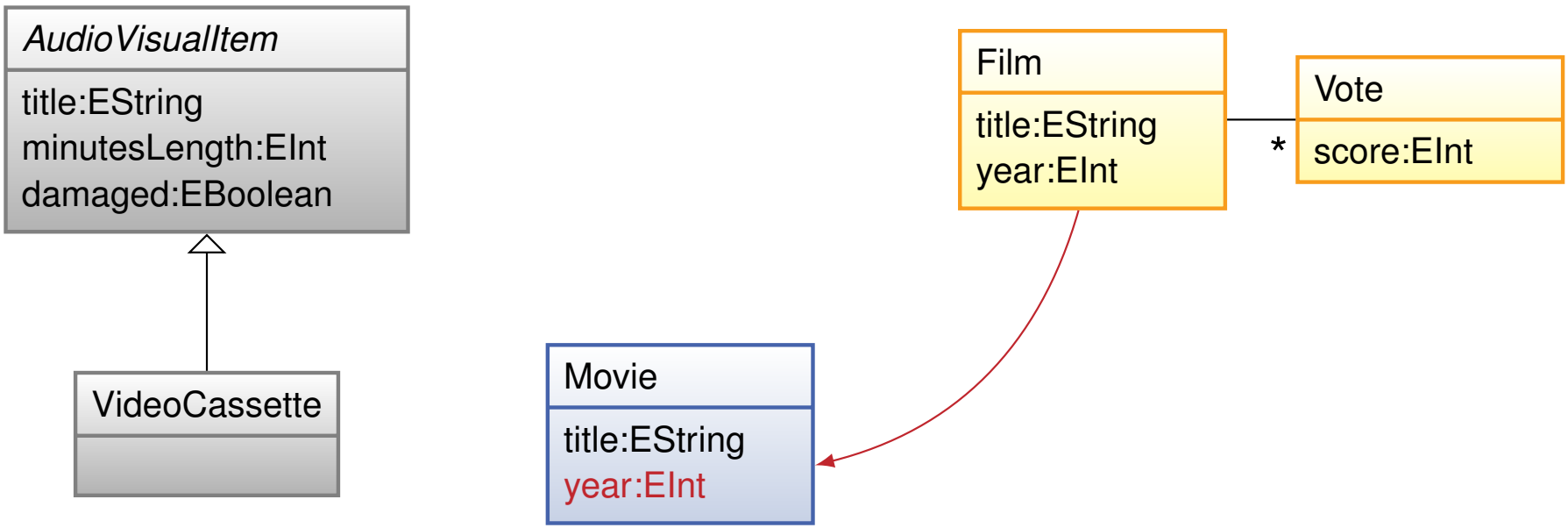

Operators: Keep

Keep Outgoing

```
keep outgoing imdb.Film.votes as type jointarget.Vote
    with keep attributes imdb.Vote.score
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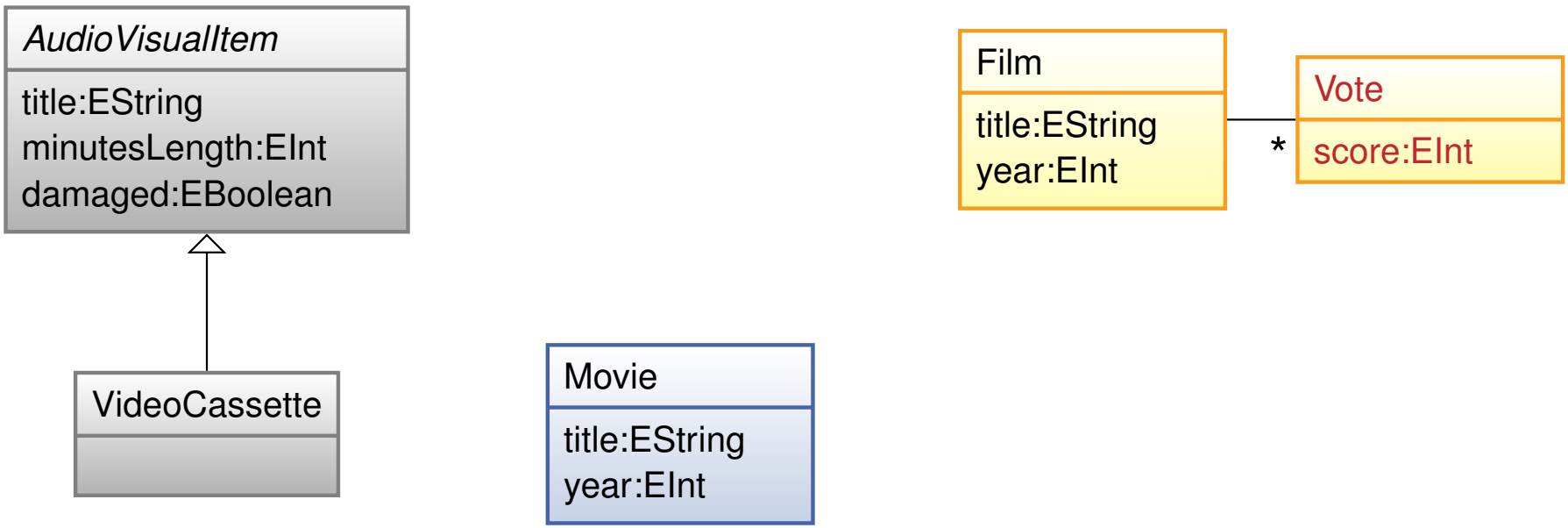

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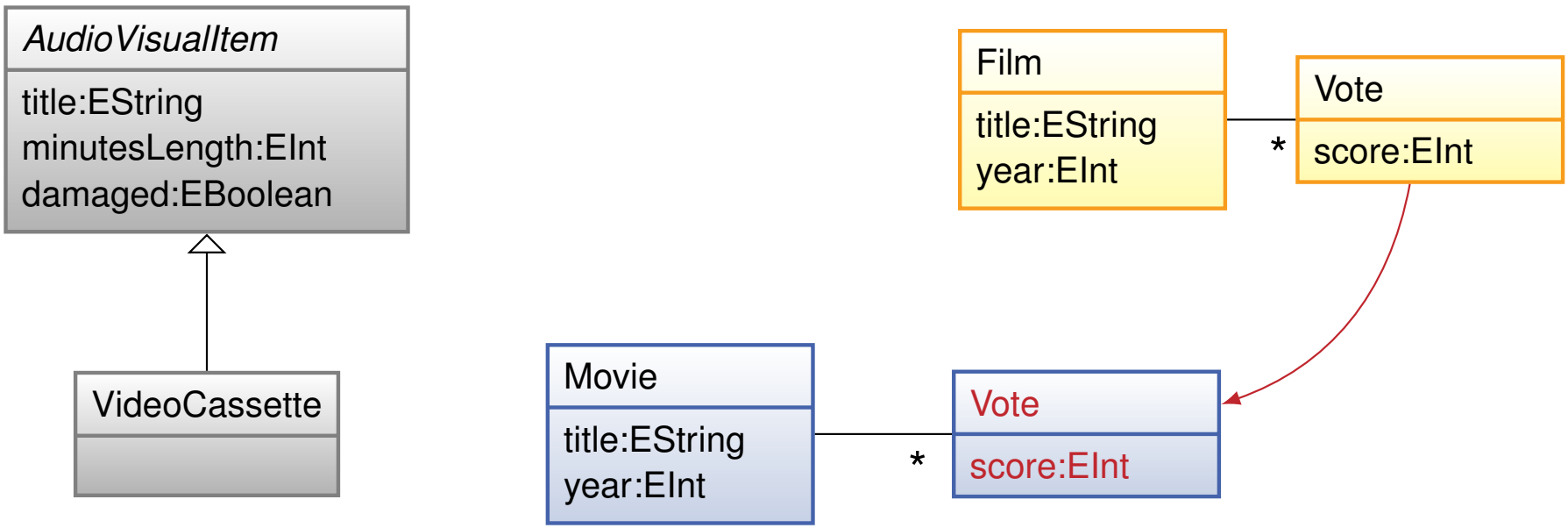

Operators: Keep

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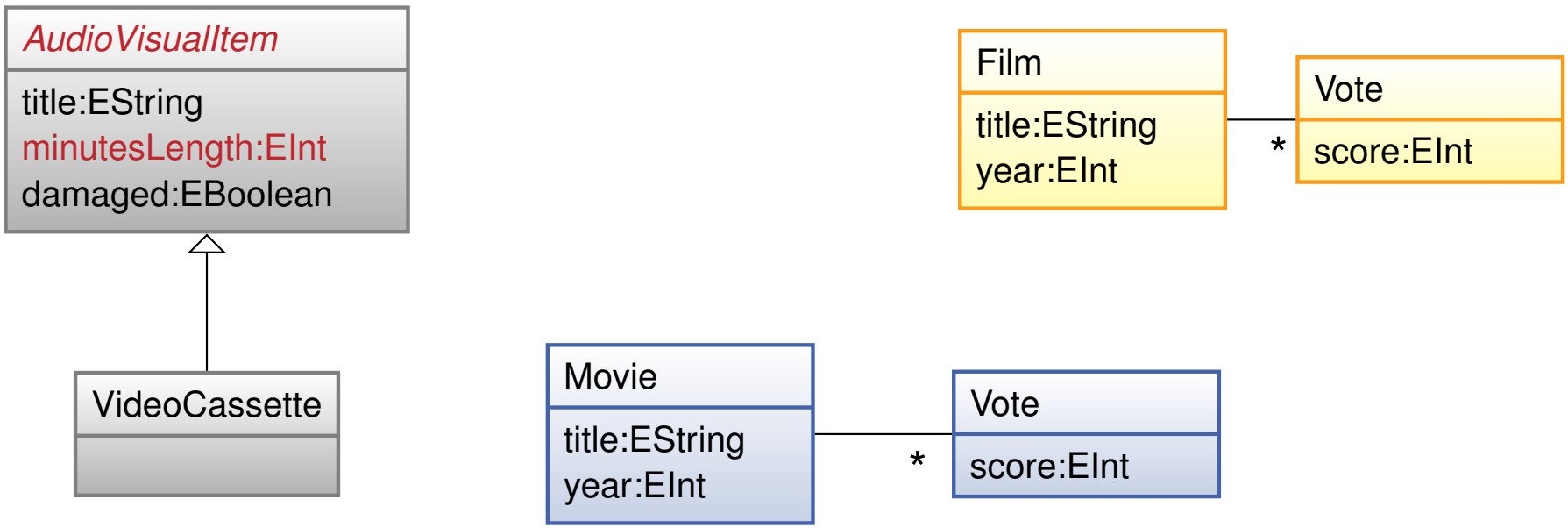
```
keep supertype library.AudioVisualItem as type jointarget.MediaItem
    with keep attributes library.AudioVisualItem.minutesLength
```



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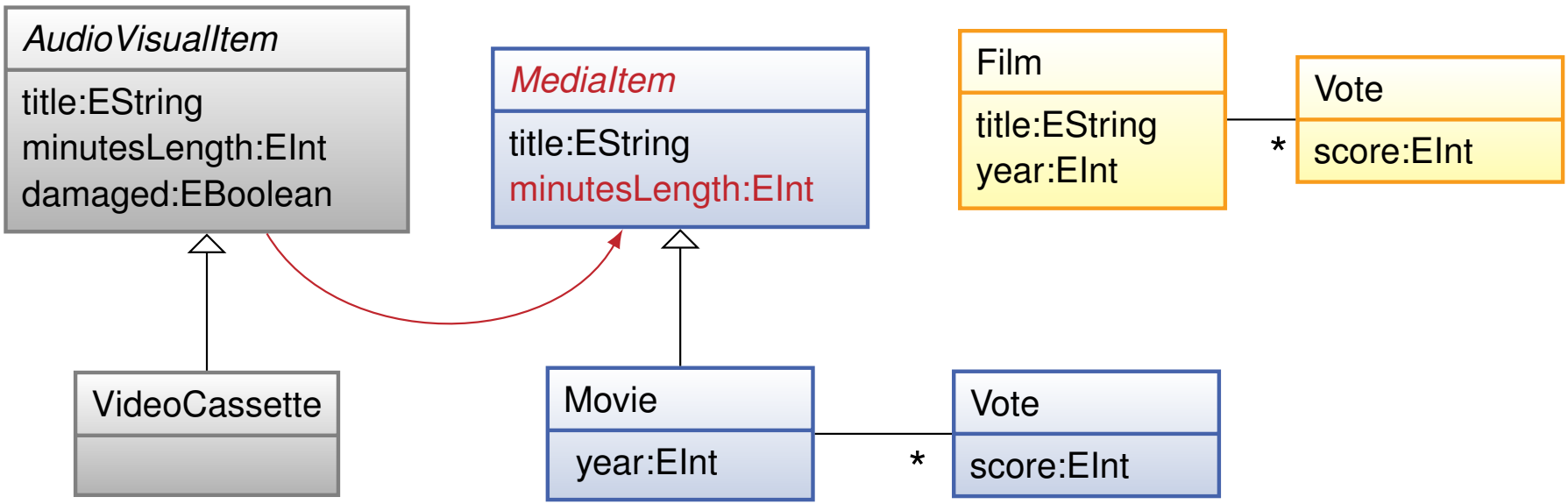

Keep operator: Notes

- if the feature does not exist in the source metamodel (e.g. in the case of `outer join`), it is set to $\perp$ in the target instances
- for this reason, the lower multiplicity of features is set to 0 if they are created because of a `keep`-statement
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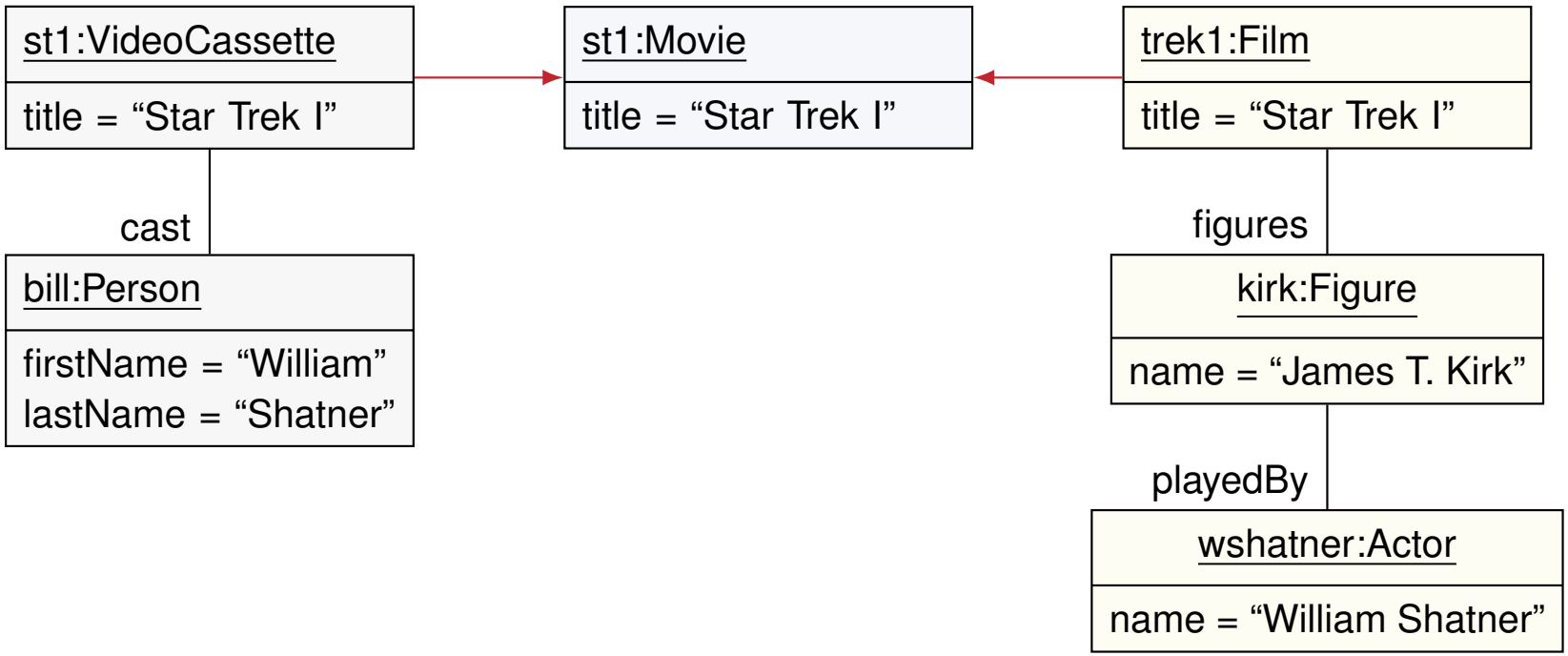
Operators: Select/Rename

Where

```
where {{ library.Videocassette.cast->forAll (p |
     imdb.Film.figures->playedBy->exists (a | p.firstname.concat("␣")
     .concat(p.lastName) == a.name)) }}
```



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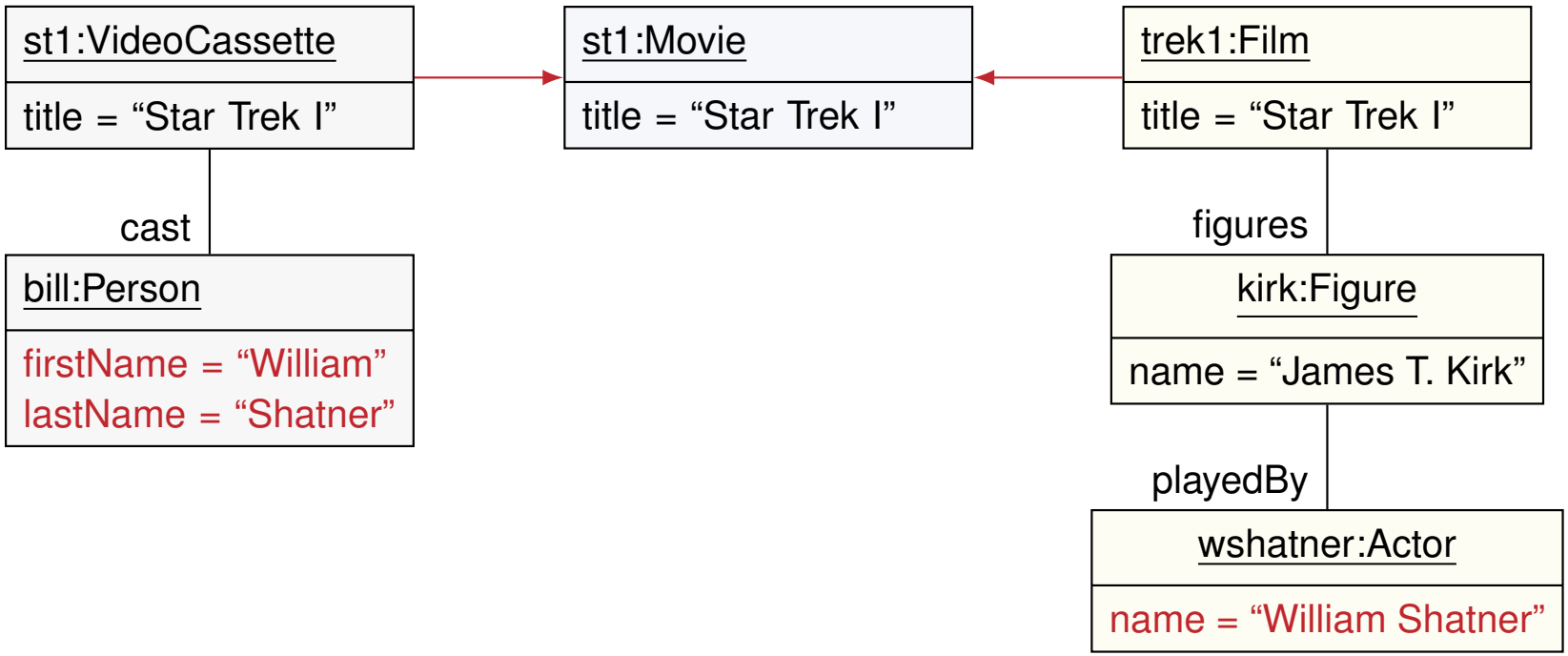

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- OCL operators offer complex join conditions in addition to default `join` operators
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Summary: ModelJoin DSL

- declarative language for metamodel and model merging
- construction of target metamodel and matching rules combined in one expression
- few automatisms; explicit definition of classes and features target metamodel by the user
- naming conflicts have to be dealt with manually

Dissociation

- not a query language
- not a transformation language
- DSL for model merging with a focus on view-based development
- not a data integration framework
- no heuristics or automatic matching of similar models
- difference from SQL:
  - SQL: reduction of a base set (cartesian product) via rules
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Outline

Implementation

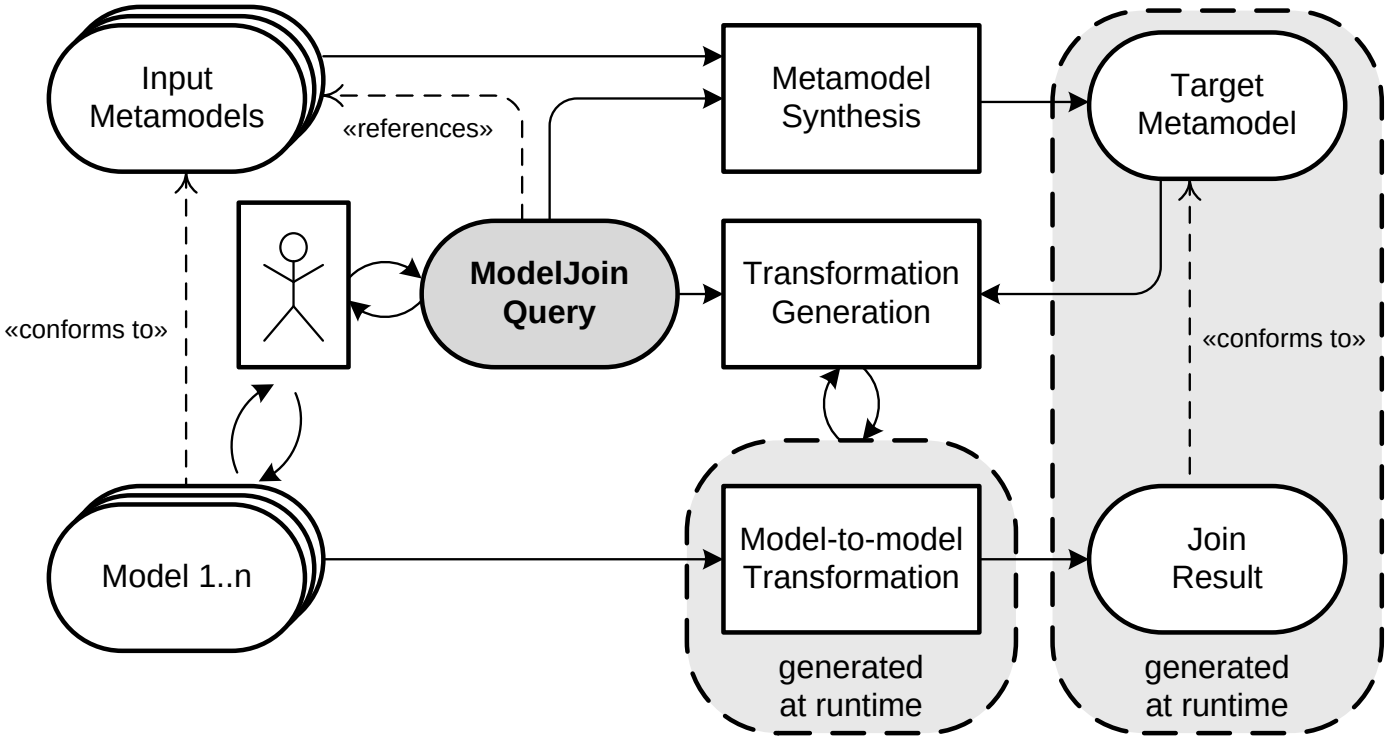

Figure: Model Workflow in FMC notation (Knopfel, Grone, and Tabeling 2006)

Skip details

Details

- *Xtext* textual syntax
- *MWE2* workflow
- metamodel synthesis by Java transformation
  1. `join`
  2. `keep supertype`
  3. `keep reference`
  4. `keep attribute`
- target metamodel and instances generated at runtime (on save)
- target metmodel does not contain references to source models

Implementation

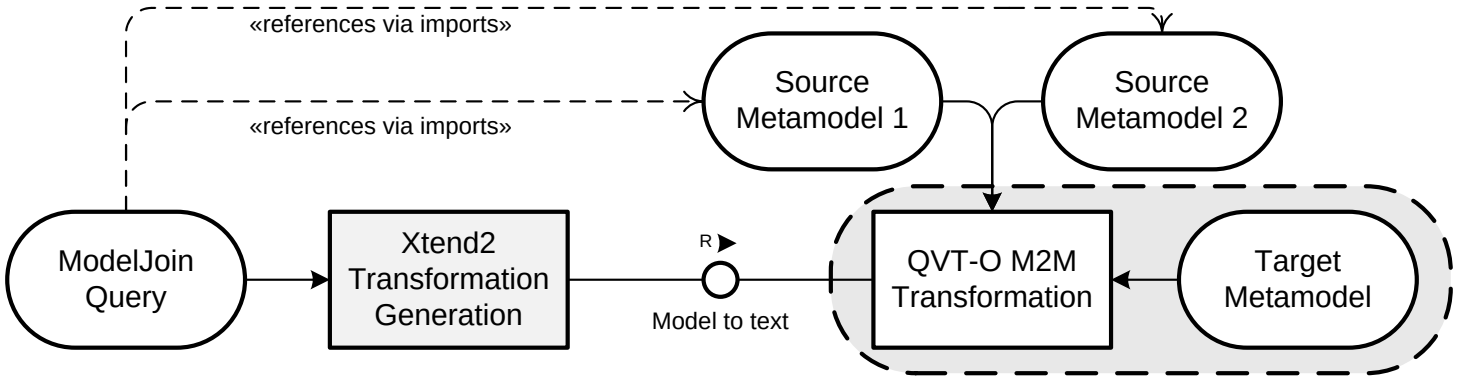

Figure: Transformation generation process

Skip details

Transformation Example

ModelQuery expression

```
natural join imdb.Film with library.VideoCassette as jointarget.Movie
    with keep attributes imdb.Film.year
```

QVT script I

```
leftAll->select(leftElement | rightAll->exists(right |
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Transformation Example

QVT script III

```
mapping _imdb::Film::JoinOperation(right : Set(_library::VideoCassette))
    : _jointarget::VideoCassette {
  title := self.title;
  year := self.year;
  right->forEach(vc) {
    if (vc.title != self.title) then continue endif;
    votes += self.votes->map VoteToVote(); // set the reference "votes"
  };
}
```

Outline

Future Work I

Bidirectionality

- reverse transformations
- editable views

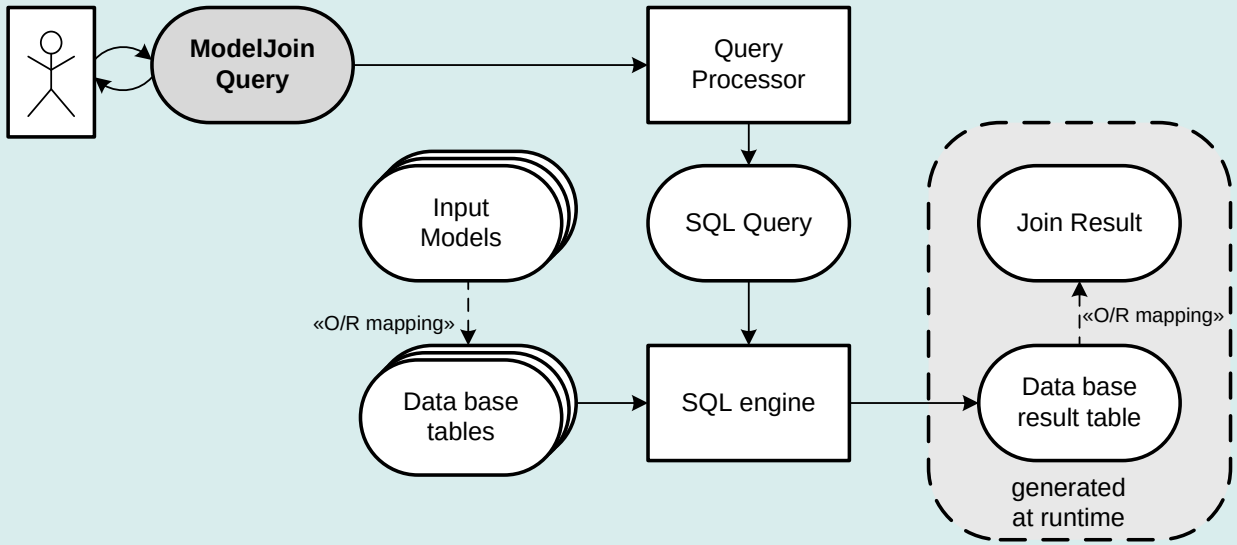
Fixed target metamodel

- for recurring join transformations
- necessary to check if ModelJoin expression conforms to target metamodel

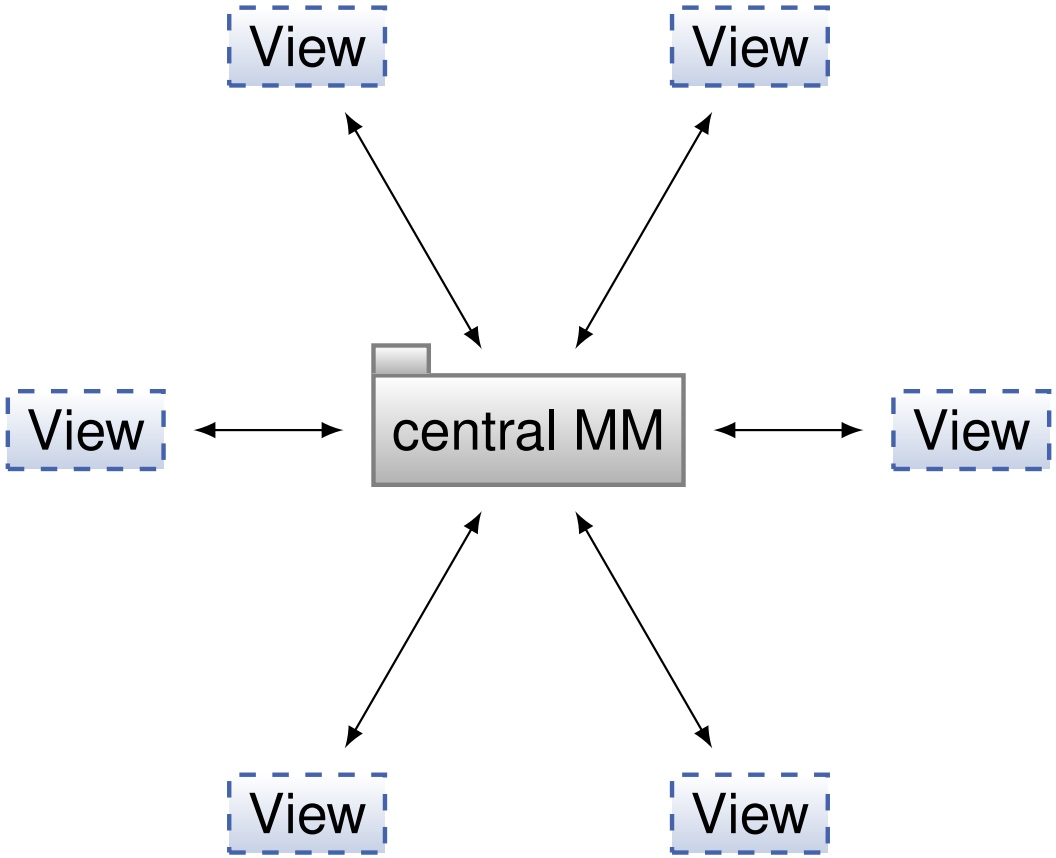
Future Work II

Different implementations

- metamodel generation with QVT (instead of Java)
- using object/relational mapping with Eclipse CDO



View-centric development



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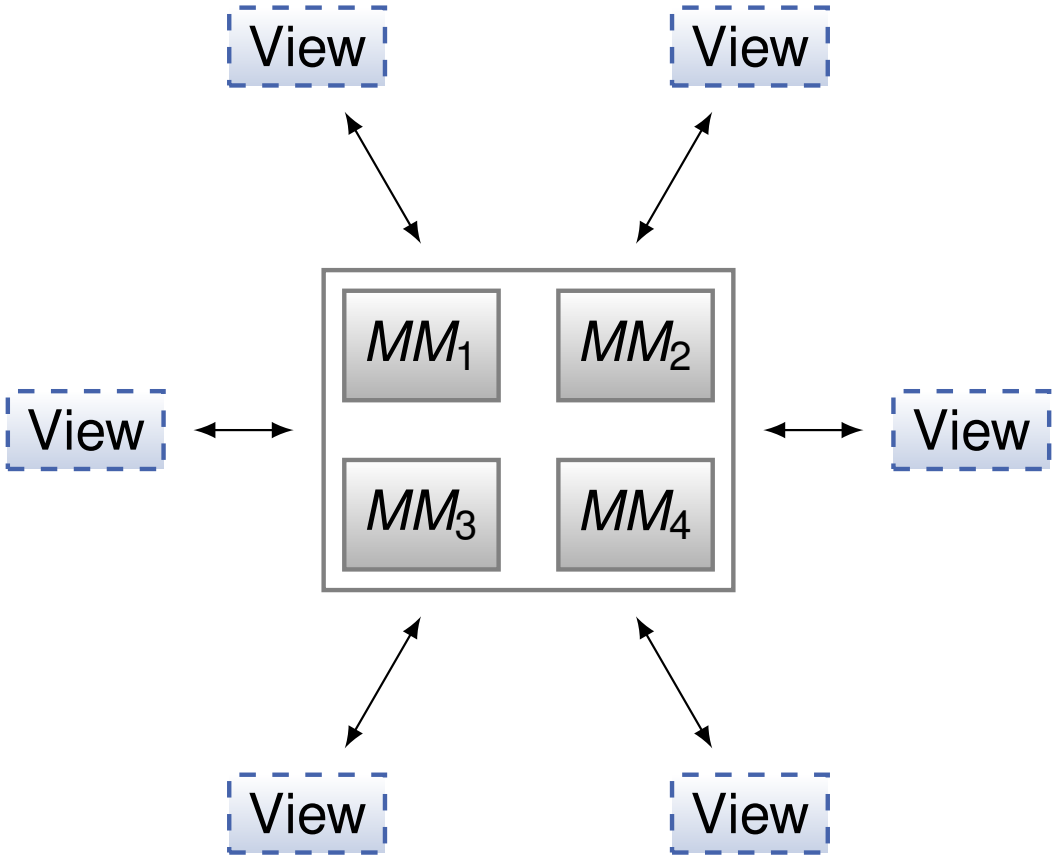

Conclusion

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References I

Andreas Knopfel, Bernhard Grone, and Peter Tabeling. *Fundamental Modeling Concepts: Effective Communication of IT Systems*. Wiley, 2006. ISBN: 978-0-470-02710-3.