On the Quest for Flexible Modelling

Esther Guerra, Juan de Lara

MISO - Modelling & Software Engineering Research Group (miso.es)
Universidad Autónoma de Madrid (Spain)

Motivation

- Diverse nature of modelling, ranging:
  - from informal (e.g., for discussion)
  - to fully formal (e.g., for code generation)
- Most modelling tools only serve one of these extreme purposes:
  - create informal models or diagrams (imprecise)
  - build models fully conformant to the modelling language (rigid)
- MDE tools on the rigid side:
  - it hinders a wider adoption of MDE
  - unnecessarily complex solutions to some scenarios

Contribution

- **Our claim: modelling tools need further flexibility**
  - cover different stages, purposes, and approaches
  - explicit modelling process and conformance rules

- In this presentation:
  - requirements for flexible modelling tools
  - application scenarios
  - our proposal: meta-modelling language + explicit modelling process
  - the Kite meta-modelling framework

Requirements

and

Scenarios

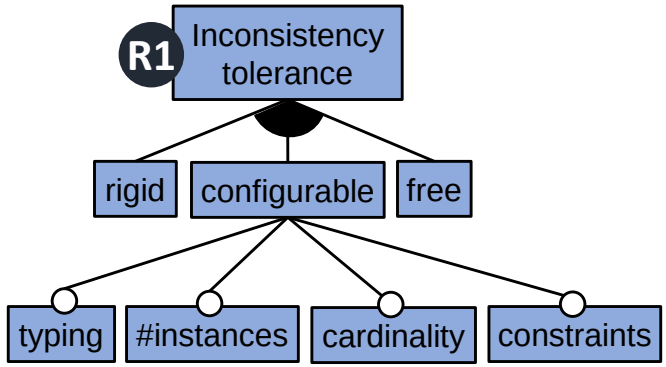
Requirements and scenarios

R1: Configurable inconsistency tolerance

R1: The user should be able to relax the model conformance rules.

Possibility to enable/disable:

- cardinality and integrity constraints
- type checking of field values
- objects with an abstract type
- objects with a non-existing type



Requirements and scenarios

R1: Configurable inconsistency tolerance

R1: The user should be able to relax the model conformance rules.

Scenarios:

- model life-cycle: from less to more strict rules
- model migration, meta-model evolution: incorrect models will "load"
- meta-model testing: partial, incorrect test models
- test-driven meta-model development: non-existing types and features

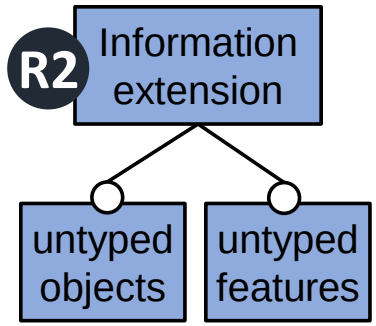
Requirements and scenarios

R2: Information extension

R2: The user should be able to dis(allow) information extension.

Possibility to have (or not):

- objects with no type (it is type-safe)
- typed objects with fields not in the object type



Requirements and scenarios

R2: Information extension

R2: The user should be able to dis(allow) information extension.

Scenarios:

- data injection: no meta-model upfront
- language extension: emergent features as untyped elements
- auxiliary computation elements: flags, clocks... as untyped elements
- language creation: creating types from untyped elements

Requirements and scenarios

R3: Configurable classification relation

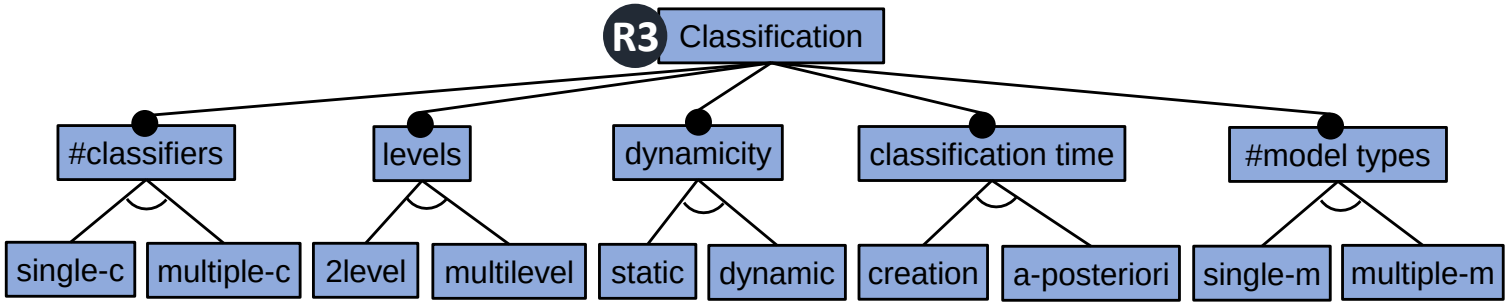
R3: The user should be able to configure the classification relation.

Possibility to enable/disable:

- dynamic, multiple typing
- creation and a-posteriori types
- multiple meta-levels

Modelling tools typically support:

- single, static typing
- creation types
- two meta-levels



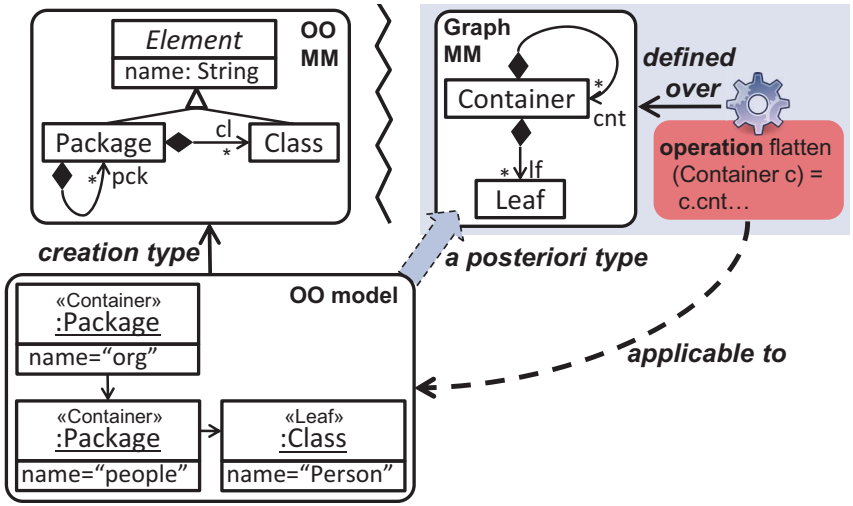
Requirements and scenarios

R3: Configurable classification relation

R3: The user should be able to configure the classification relation.

Scenarios:

- reuse of model operations: by allowing multiple typing



- joint instantiation of sets of classes: e.g., used in ontologies
- multi-level modelling: by allowing multiple meta-levels

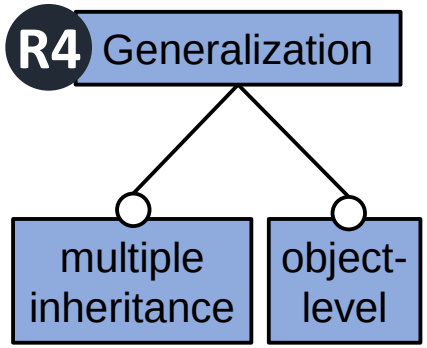
Requirements and scenarios

R4: Configurable generalisation relation

R4: The user should be able to configure the generalisation relation.

Possibility to enable/disable:

- multiple inheritance
- generalisation between objects



Requirements and scenarios

R4: Configurable generalisation relation

R4: The user should be able to configure the generalisation relation.

Scenarios:

- model libraries: reusable by object inheritance

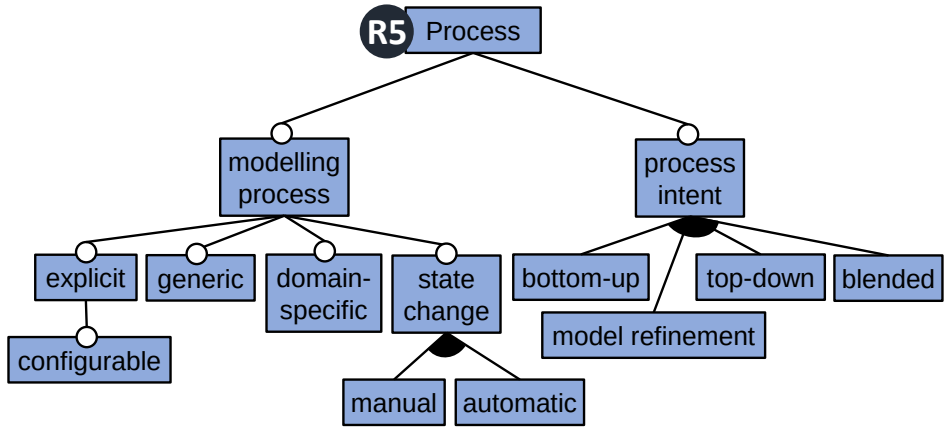
Requirements and scenarios

R5: Explicit and configurable modelling process

R5: The tool should allow defining and enacting modelling processes.

Modelling processes:

- phases, conformance rules
- order of object creation
- current modelling phase
  - manual
  - automatic
- process intent
  - meta-model creation (bottom-up, top-down, blended)
  - model creation



Requirements and scenarios

R5: Explicit and configurable modelling process

R5: The tool should allow defining and enacting modelling processes.

Scenarios:

- transition from informal to formal modelling
- modelling guidelines: e.g., in UML, classes first

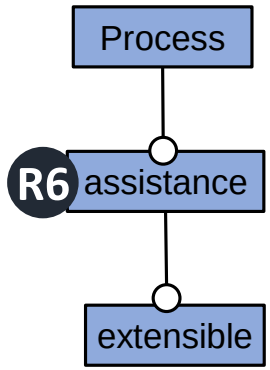
Requirements and scenarios

R6: Process-aware extensible assistance

R6: Fixes and refactorings may depend on the process intent.

For example, given a model error:

- bottom-up fixes modify the meta-model
- top-down fixes modify the model
- domain-specific fixes



Requirements and scenarios

R6: Process-aware extensible assistance

R6: Fixes and refactorings may depend on the process intent.

Scenarios:

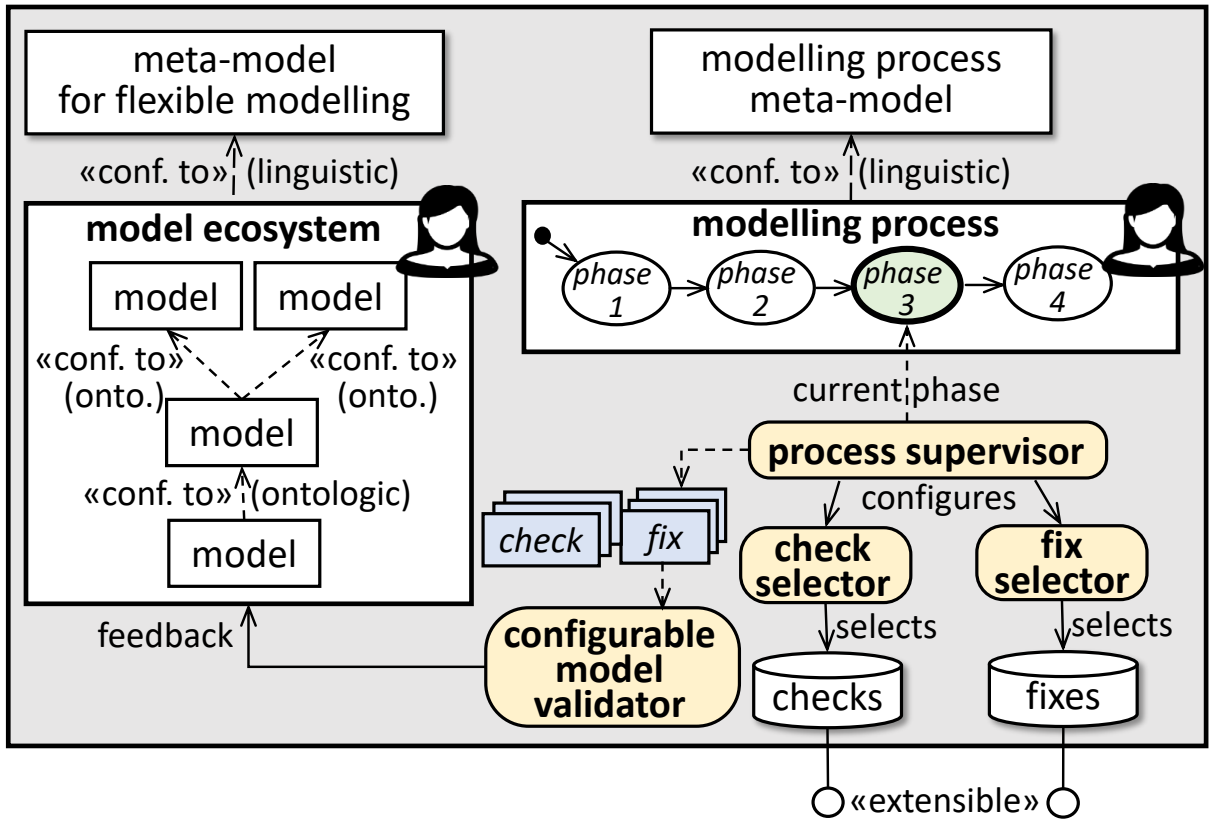
- model refinement: model fixes and refactorings
- live meta-model/model co-evolution: model fixes and refactorings
- bottom-up meta-modelling: meta-model fixes
- recommendation systems

Our

Proposal

Architecture

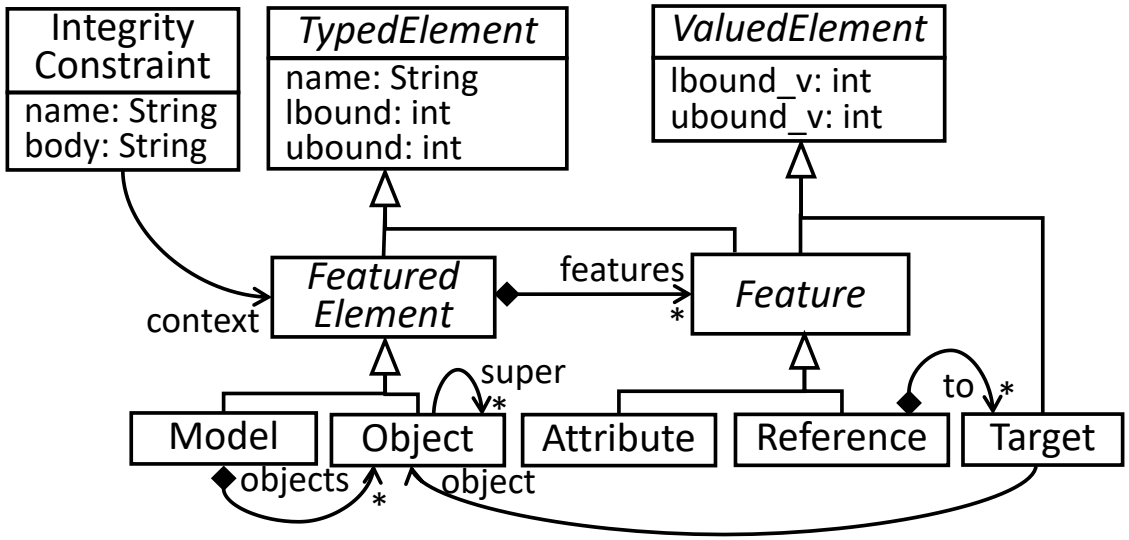
- meta-modelling language for flexible modelling
- explicit modelling process



Meta-modelling language

Basic modelling elements (R3, R4)

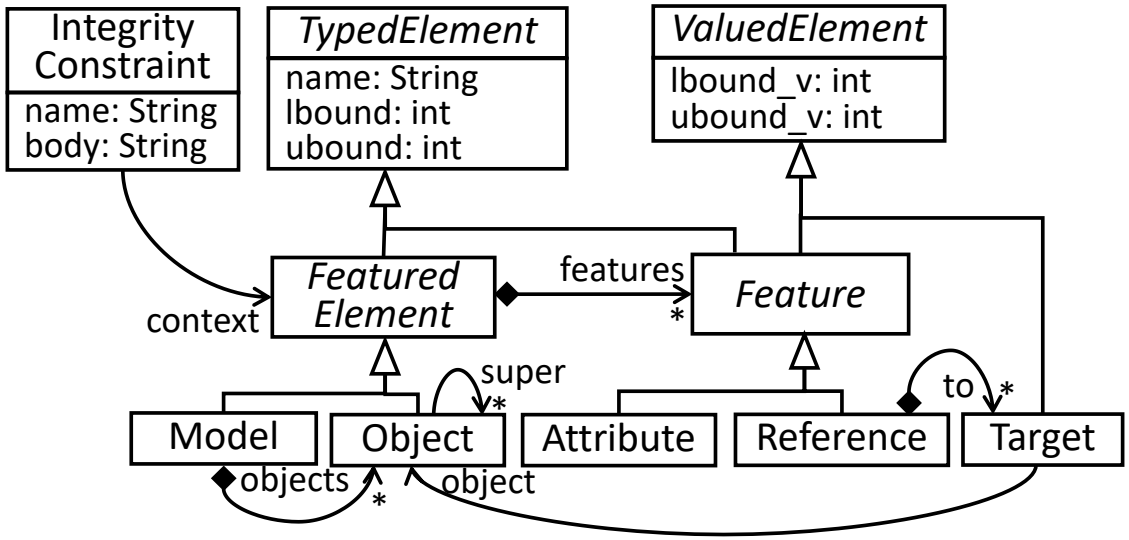
- Support for multiple levels (one class to represent types and instances)
- Models and objects can have features and constraints
- Instantiation cardinality vs Value cardinality
- References can have several targets, at any level
- Generalization at any meta-level (relation Object.super)



Meta-modelling language

Basic modelling elements (R3, R4)

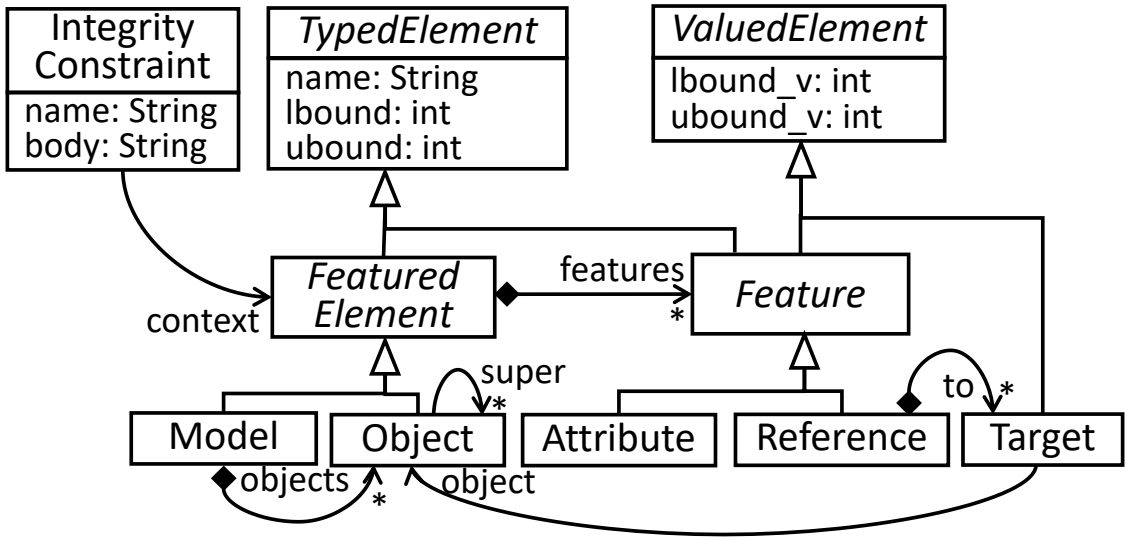
- Support for multiple levels (one class to represent types and instances)
- Models and objects can have features and constraints
- Instantiation cardinality vs Value cardinality
- References can have several targets, at any level
- Generalization at any meta-level (relation Object.super)



Meta-modelling language

Basic modelling elements (R3, R4)

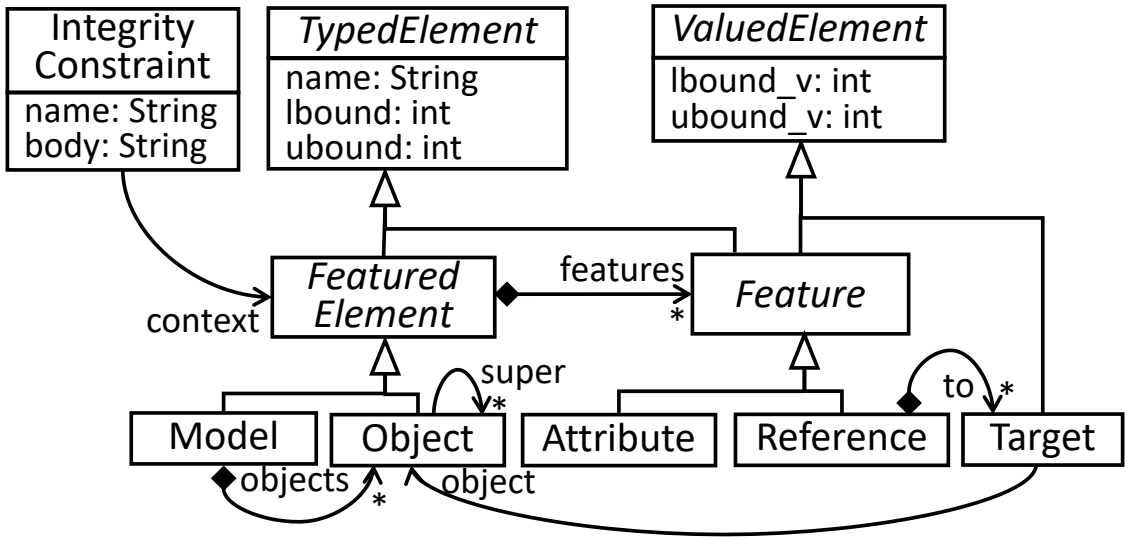
- Support for multiple levels (one class to represent types and instances)
- Models and objects can have features and constraints
- Instantiation cardinality vs Value cardinality
- References can have several targets, at any level
- Generalization at any meta-level (relation Object.super)



Meta-modelling language

Basic modelling elements (R3, R4)

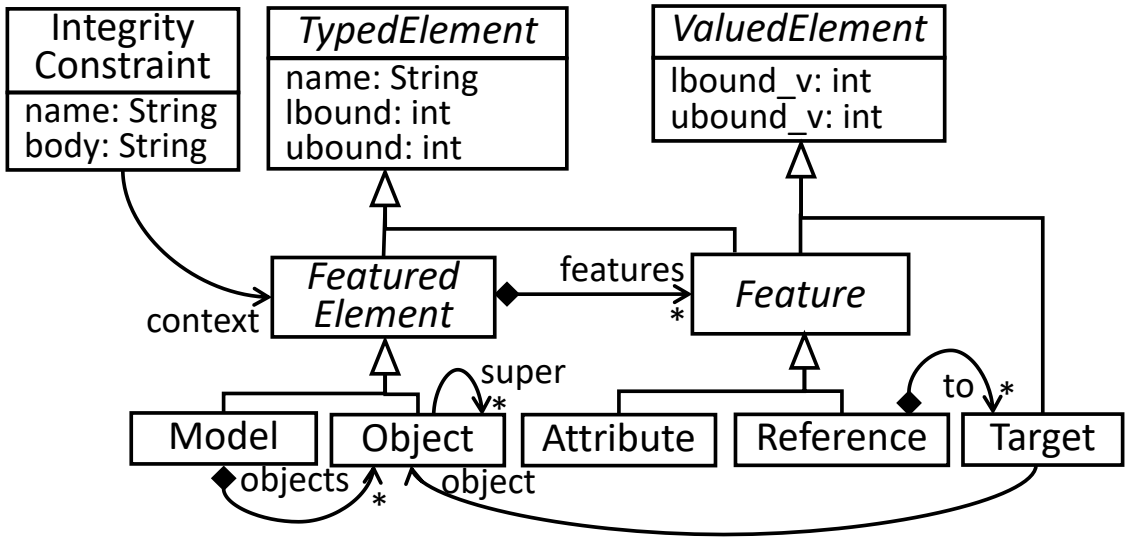
- Support for multiple levels (one class to represent types and instances)
- Models and objects can have features and constraints
- Instantiation cardinality vs Value cardinality
- References can have several targets, at any level
- Generalization at any meta-level (relation Object.super)



Meta-modelling language

Basic modelling elements (R3, R4)

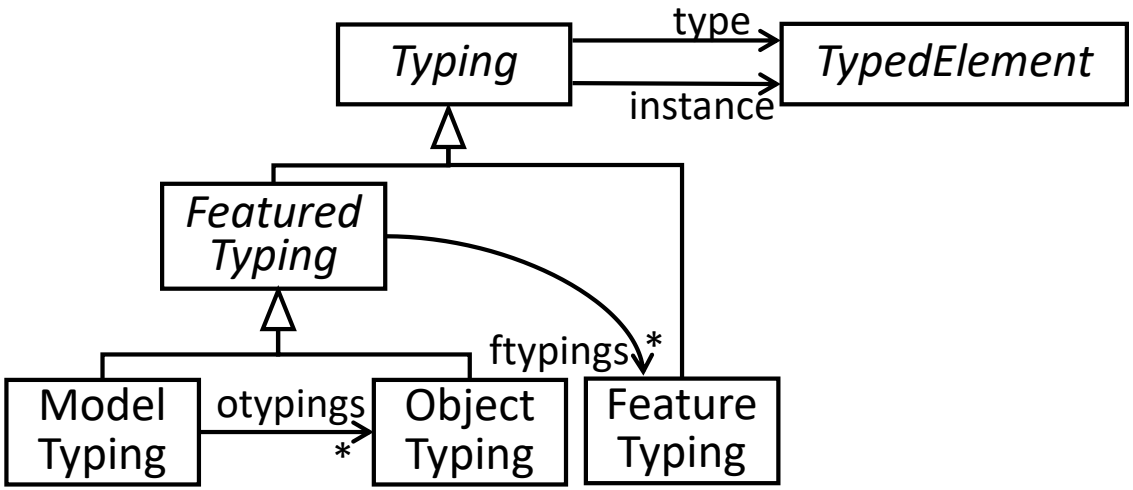
- Support for multiple levels (one class to represent types and instances)
- Models and objects can have features and constraints
- Instantiation cardinality vs Value cardinality
- References can have several targets, at any level
- Generalization at any meta-level (relation Object.super)



Meta-modelling language

Flexible typing (R1, R2, R3)

- Explicit typing relation
  - Zero, one or more typings for an instance
  - Types can be assigned at creation time, or later
  - Re-typing (preserving the instance identity)



Meta-modelling language

Examples

```
1  Conference {
2     Author {}
3     Reviewer /1..*/ {}
4  }
5
6  MODELS :Conference /0..0/ {
7     amelia :Author :Reviewer {}
8     lateReviews {
9        ref who = amelia;
10    }
11 }
```

Meta-modelling language

Examples

```
1  Conference {
2     Author {}
3     Reviewer /1..*/ {} -->  instantiation cardinality
4  }
5
6  MODELS :Conference /0..0/ { -->  instantiation cardinality
7     amelia :Author :Reviewer {}
8     lateReviews {
9        ref who = amelia;
10    }
11 }
```

Meta-modelling language

Examples

```
1  Conference {
2     Author {}
3     Reviewer /1..*/ {}
4  }
5
6  MODELS :Conference /0..0/ {
7     amelia :Author :Reviewer {} --> object with multiple types
8     lateReviews {
9        ref who = amelia;
10    }
11 }
```

Meta-modelling language

Examples

```
1  Conference {
2     Author {}
3     Reviewer /1..*/ {}
4  }
5
6  MODELS :Conference /0..0/ {
7     amelia :Author :Reviewer {}
8     lateReviews { -->  object with no types
9        ref who = amelia;
10    }
11 }
```

Meta-modelling language

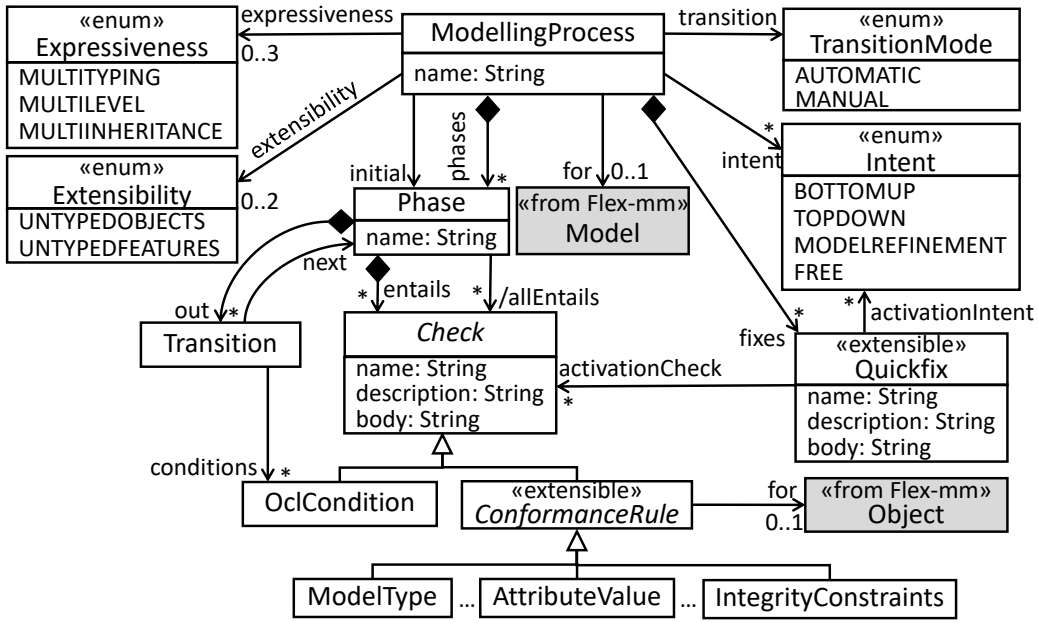
Examples

```
1  ArtistTypes {
2    Singer {
3      att name : String;
4      att stageName : String;
5    }
6  }
7
8  SomeMusicians :ArtistTypes {
9    tina :Singer {
10     att name = "Anna Mae Bullock";
11     att stageName = "Tina Turner";
12   }
13   joaquin :Singer {
14     att realName (:name :stageName) = "Joaquin Pascual";
15   }
16 }
```

Reified modelling process

Explicit modelling process (R5, R6)

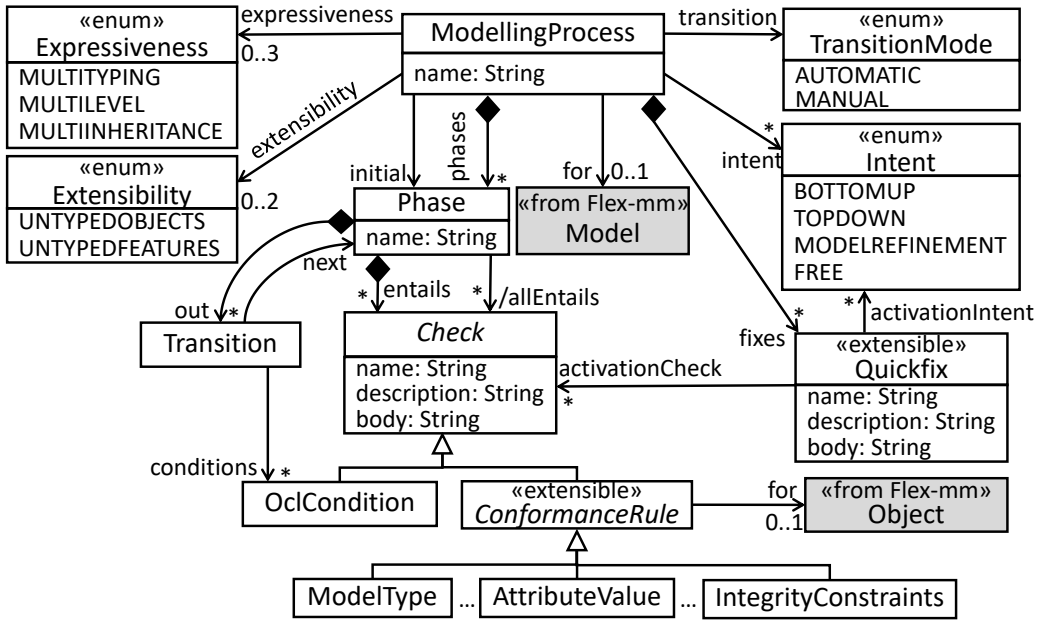
- Explicit modelling process: phases, checks, transitions
  - checks: predefined conformance rules, or custom-made ocl conditions
  - transitions: manual or automatic, may define ocl conditions
- Process intent: refinement, top-down, bottom-up, free
- Quick fixes can be filtered by process intent
- Conformance rules and quickfixes can be extended by users



Reified modelling process

Explicit modelling process (R5, R6)

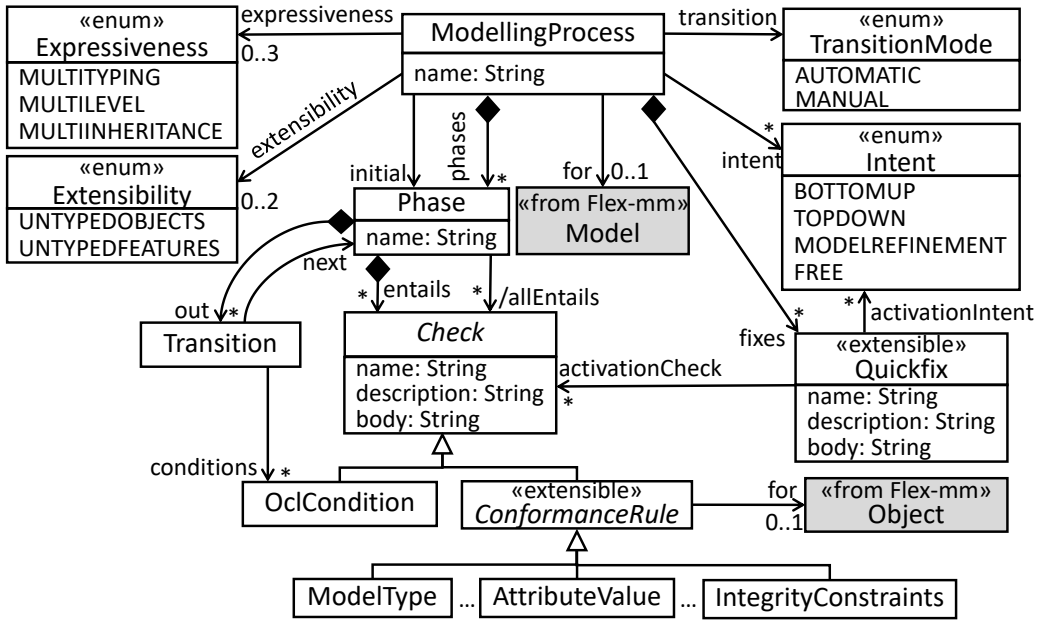
- Explicit modelling process: phases, checks, transitions
  - checks: predefined conformance rules, or custom-made ocl conditions
  - transitions: manual or automatic, may define ocl conditions
- Process intent: refinement, top-down, bottom-up, free
- Quick fixes can be filtered by process intent
- Conformance rules and quickfixes can be extended by users



Reified modelling process

Explicit modelling process (R5, R6)

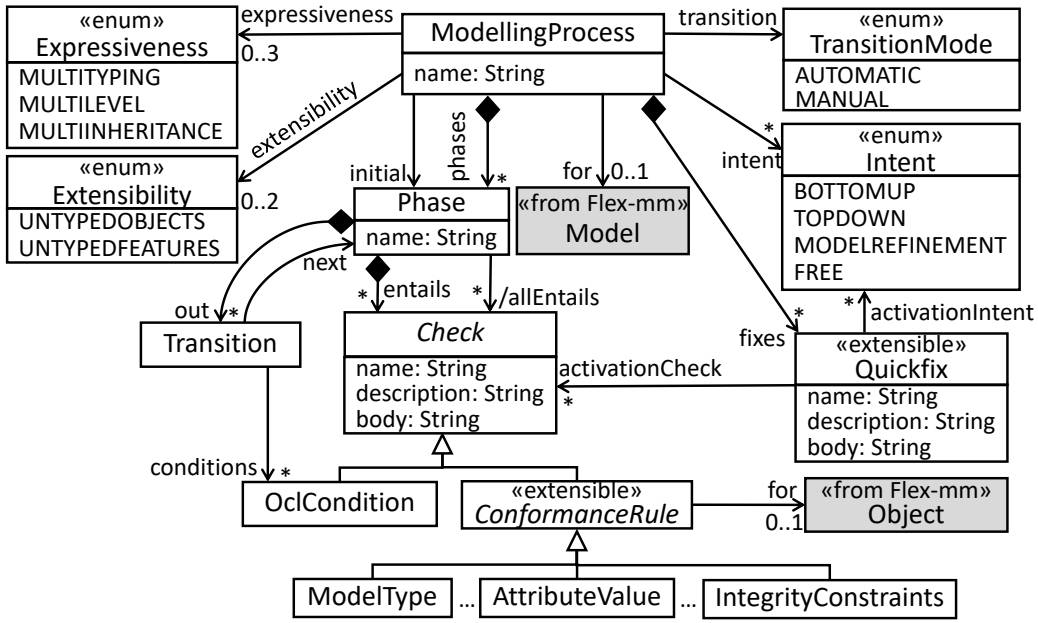
- Explicit modelling process: phases, checks, transitions
  - checks: predefined conformance rules, or custom-made ocl conditions
  - transitions: manual or automatic, may define ocl conditions
- Process intent: refinement, top-down, bottom-up, free
- Quick fixes can be filtered by process intent
- Conformance rules and quickfixes can be extended by users



Reified modelling process

Explicit modelling process (R5, R6)

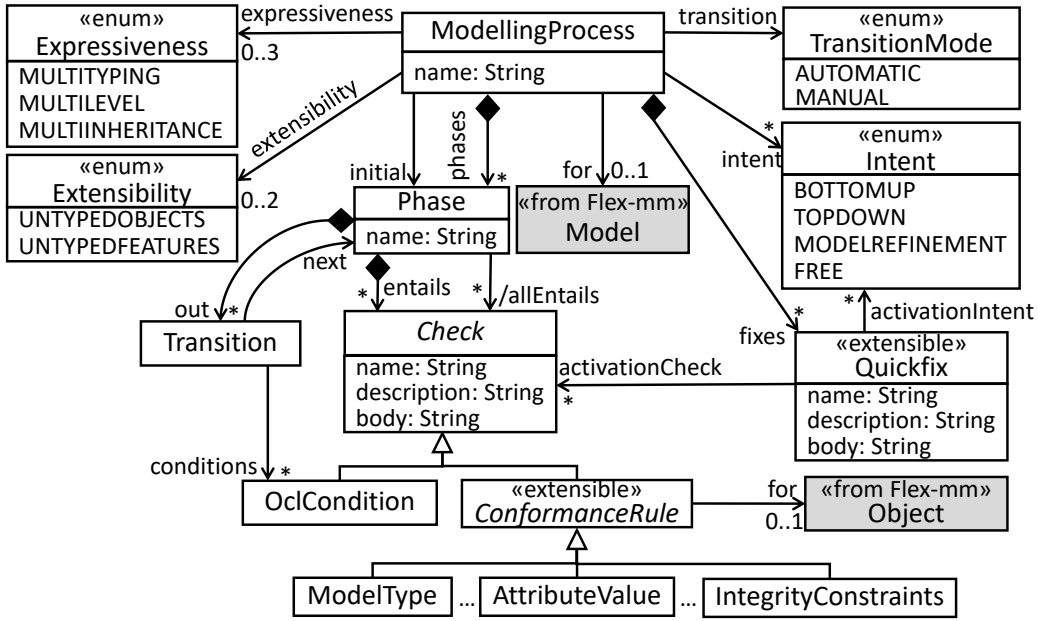
- Explicit modelling process: phases, checks, transitions
  - checks: predefined conformance rules, or custom-made ocl conditions
  - transitions: manual or automatic, may define ocl conditions
- Process intent: refinement, top-down, bottom-up, free
- Quick fixes can be filtered by process intent
- Conformance rules and quickfixes can be extended by users



Reified modelling process

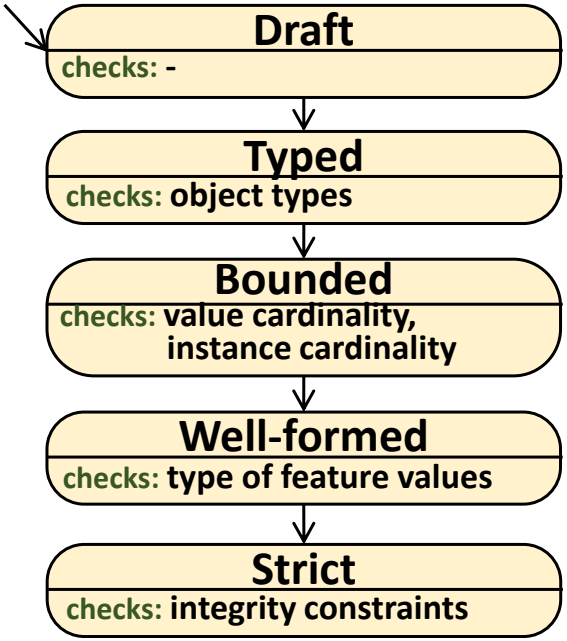
Further configuration options (R5, R6)

- Configuration of the meta-modelling language:
  - expresiveness: multiple typing, multiple levels, multiple inheritance
  - extensibility: untyped objects, untyped features

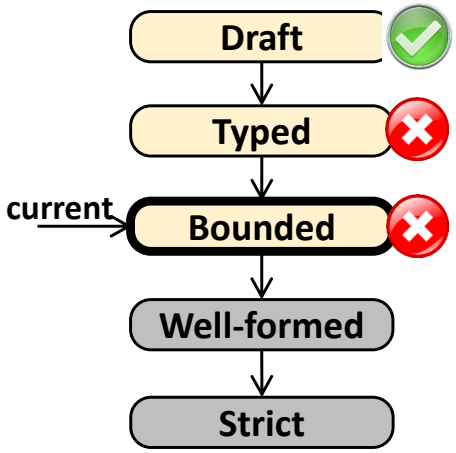


Reified modelling process

Examples



Intent: ModelRefinement
TransitionMode: Manual
Expressiveness: MultiTyping, MultiInheritance
Extensibility: UntypedObjects, UntypedFeatures

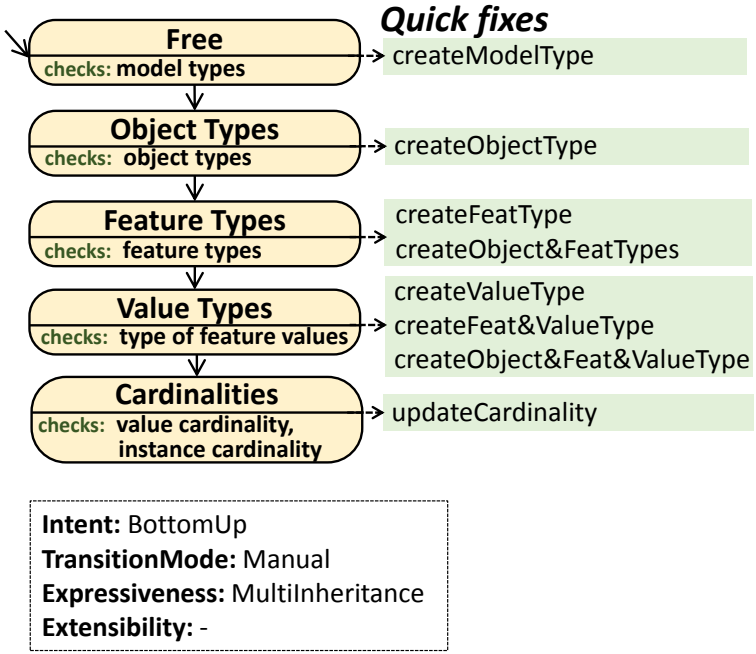



```
1  Conference {
2    Author {}
3    Reviewer /1..*/ {}
4  }
5
6  MODELS :Conference {
7    amelia :Author :Reviewer {}
8    lateReviews :Comment {
9      ref who : amelia;
10   }
11 }
```

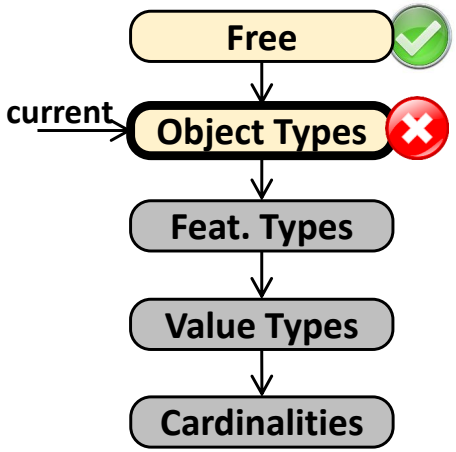
Fixes (refinement)
- remove type
- change to Author/Reviewer

Reified modelling process

Examples



Intent: BottomUp
TransitionMode: Manual
Expressiveness: MultiInheritance
Extensibility: -

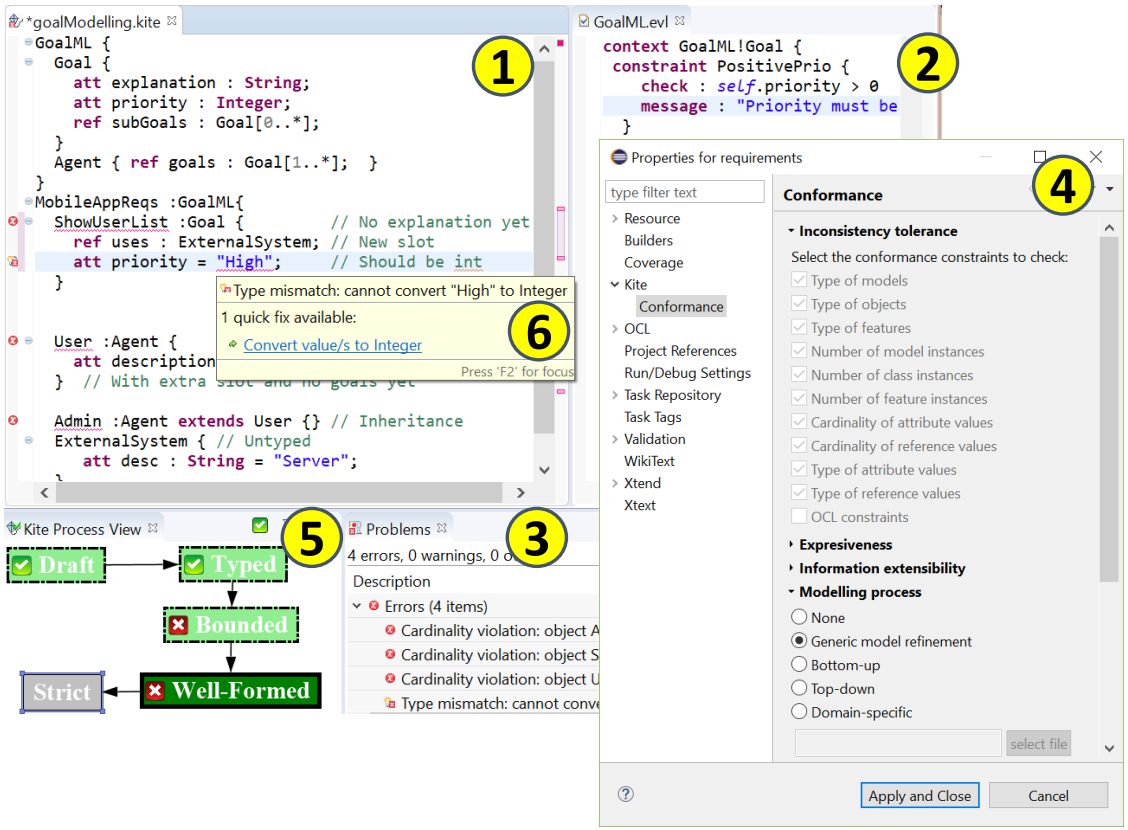



```
1  Conference {
2    Author {}
3    Reviewer /1..*/ {}
4  }
5
6  MODELS :Conference {
7    amelia :Author :Reviewer {}
8    lateReviews :Comment {
9      ref who : amelia;
10   }
11 }
```

Fixes (bottomup)
- Add new type Comment

Our prototype implementation Kite

- Kite is an eclipse textual editor for flexible modelling
- Based on EMF (for inter-operability), Xtext, and EVL (constraints)



Conclusions

Summary

- Flexibility in modelling tools is useful in many scenarios
- List of requirements for flexible modelling tools:
  - flexible typing
  - explicit modelling process
- Initial proposal and implementation
- In the paper: review of existing flexible (meta-)modelling tools
  - support for flexibility is only partial
  - big gap on explicit modelling processes (opportunity!)

Next steps

- Improving Kite, e.g., DSL to define modelling processes
- Integration with further model management languages
- Extend reasoners to work with non-fully conformant models
- Explore others aspects of flexibility, like concrete syntax
- Meta-object protocols to extend meta-modelling facilities

On the Quest for Flexible Modelling

Esther Guerra, Juan de Lara
esther.guerra@uam.es

MISO - Modelling & Software Engineering Research Group (miso.es)
Universidad Autónoma de Madrid (Spain)

Comments? Questions?