Language, Models and Megamodels

Tutorial on Megamodelling

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Learning Outcomes

- What is a model? ...a metamodel? ...a megamodel?
- Why would you need one?
- Relations between models
- Kinds of megamodels
- Mega patterns
- Practical megamodelling

I’m a language engineer, so we’ll start from a language perspective.
A language
- is a form of communication
- has structure
- carries meaning
- is/creates abstraction
Languages

Kinds:
- Natural
- Artificial
  - Formal

Forms:
- Written
- Spoken
- Diagrams

Purpose:
- General-Purpose
  *Can define arbitrary abstractions*
- Domain-specific

Software language: *Artificial language used in software development*
- Programming, Modelling,
  Data representation,
  Ontologies, APIs, ...
What’s a model?

A model is a simplification of a system build with an intended goal in mind. The model should be able to answer questions in place of the actual system.

- Typically, a model represents a system
- System may be abstract or real
- May also be used in the sense of a type/class, example, instance, mold
- Descriptive or prescriptive

* [Bézivin, Gerbé, Towards a Precise Definition of the OMG/MDA Framework]
...aaand a metamodel?

A metamodel is model of a modelling language

Modelling Language

Metamodel "conformsTo" Model

Metamodel "writtenIn" Modelling Language

Model "conformsTo" Metamodel

Solar System Model

GRADING GUIDELINES:
You will build a Solar System model. It should:

- Include the sun, 8 planets, and Earth's moon. (20 points)
- Include and label 2 of the following: asteroid, comet, meteor, or constellation. (5 points)
- Neatly label each planet. (10 points)
- Neatly label each planet's distance from the sun in MILES and convert to smaller units. (5 points)
- Be creative, colorful, and interesting. (15 points) - Label the inner and outer planets. (5 points)
- You are welcome to include anything additional on your model. It will count as extra credit!
A megamodel is a model of a system of models.
A Totally Unrelated Example: Climate Modelling
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Why Would You Need a Megamodel?

To understand your system:

- Models have implicit relations and assumptions:
  - What technologies are in the environment?
  - How does this model relate to other models? (e.g. models may show different views of same system)
- Systems of models may very complex
  - Need a model to understand them!
- Supporting MDE with model management
- Define software architecture

Things to model:

- Languages
- Technologies
- Programs
- Transformations
- Relations
- ...

Relationships:

- Conformance
- Transformation
- Composition
- Representation
- ...

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Ad hoc megamodelling:
- Draw a diagram with models
- Add relations between them
- Relations are in natural language

Focus is on understanding and communicating.

Jean-Marie’s relations:
- \( \mu \): representationOf
- \( \epsilon \): elementOf
- \( \delta \): decomposedIn
- \( \chi \): conformsTo

E.g.: Program is ElementOf Language, Grammar is RepresentationOf Language, Program ConformsTo Grammar, System is DecomposedIn Component
Megamodel Relations

Relations in MegaL:

[Favre, Lämmel, and Varanovich, *Modeling the Linguistic Architecture of Software Products*]
Megamodel Relations

Relations in MegaL:

- :Language subsetOf :Language
- :Artifact elementOf :Language
- :Language domainOf :Function
- :Function hasRange :Language
- :FunctionApplication elementOf :Function
- :Artifact inputOf :FunctionApplication
- :FunctionApplication hasOutput :Artifact
- :Artifact conformsTo :Artifact
- :Artifact partOf :Artifact
- :Artifact correspondsTo :Artifact
- :Artifact dependsOn :Artifact
- :Artifact dependsOn :Language
- :Artifact realizationOf :Function
- :Artifact definitionOf :Language
- :Program partOf :Technology
- :Library partOf :Technology

[Favre, Lämmel, and Varanovich, *Modeling the Linguistic Architecture of Software Products*]
Example:
Specification/Language/Program or Metamodel/Language/Model

[Favre, Megamodelling and etymology. A story of words: from MED to MDE via MODEL in five millennia]
Practical Megamodelling: Modelling Language Artifacts

[Zaytsev & Bagge: Parsing in a Broad Sense]
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Zaytsev & Bagge: Parsing in a Broad Sense

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[Favre, Lämmel, and Varanovich, *Modeling the Linguistic Architecture of Software Products*]
Another Example: Astronomical Simulation Software

[Favre, Megamodelling and etymology. A story of words: from MED to MDE via MODEL in five millenniums]
Summary

- Language is structured and meaningful communication
- Models abstract over and represent systems
- Metamodels are models of (modelling) languages
- Megamodels are models of systems of models
  - Aimed at understanding (for humans)
  - Makes relationships explicit
  - Identifies roles – and missing models