Frictional Forces in Metamodeling: A Case Study

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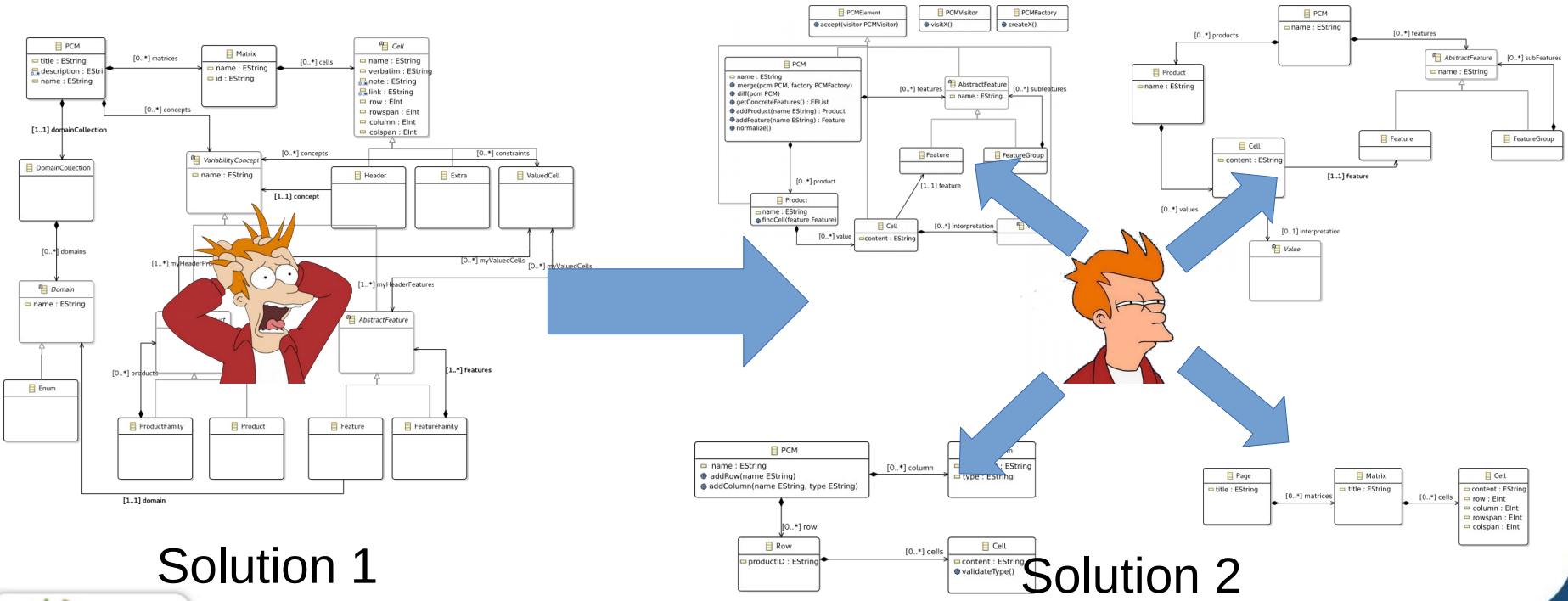
Metamodeling

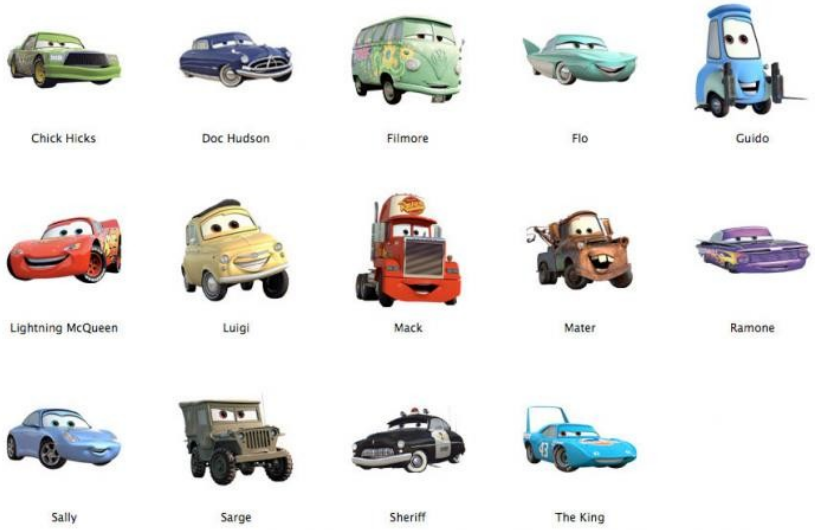
- Metamodeling is a crucial yet difficult activity that allows to define a domain, represent data, build tools, etc.
- Multi-objective problem
- Case study: OpenCompare



Solution 1

Solution 2

Case Study: OpenCompare



Product lines everywhere !

Case Study: OpenCompare

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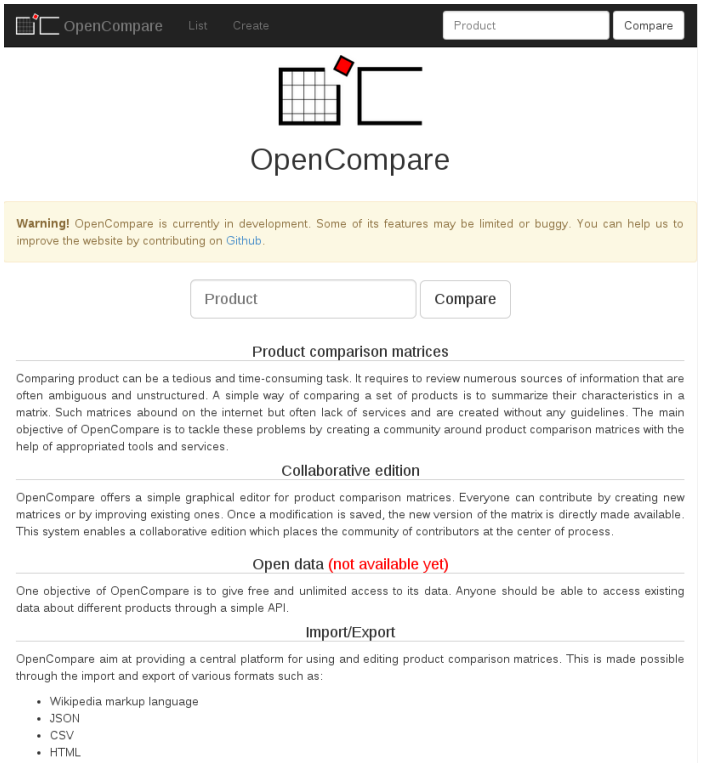
WIKIPEDIA
The Free Encyclopedia

- Product Comparison Matrices (PCM)
  - Good properties: simplicity, synthesis, easy to write, widely used and generic
  - Bad properties: ambiguity, lack of scalability, excess of equality, lack of support and services
- Need for a systematic engineering approach

Case Study: OpenCompare

- OpenCompare
  - PCM editor
  - Import and export numerous formats (e.g. Wikipedia, spreadsheets, online APIs)
  - Innovative services (e.g. configurators, recommending systems, visualizers)



- Model-based solution for managing, editing and exploiting PCMs
- Elaboration of a (set of) metamodel(s) to ease the encoding, edition and transformation of PCMs

Research Questions

- How to define a (set of) metamodel(s) that allows stakeholders to encode, interoperate, edit, and process models in an intuitive yet precise manner?
- **RQ1:** What are these forces that influence the metamodeling process?
- **RQ2:**
  - Are there some conflicting forces?
  - Is a unique metamodel a suitable and feasible solution?
- **RQ3:** Are there mechanisms (e.g., design patterns) for elaborating or deriving force-specific metamodels?

First solution: a unique metamodel

Automating the Formalization of Product Comparison Matrices

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ABSTRACT

Product Comparison Matrices (PCMs) form a rich source of data for comparing a set of related and competing products over numerous features. Despite their apparent simplicity, PCMs contain heterogeneous, ambiguous, uncontrolled and partial information that hinders their efficient exploitations. In this paper, we formalize PCMs through model-based automated techniques and develop additional tooling

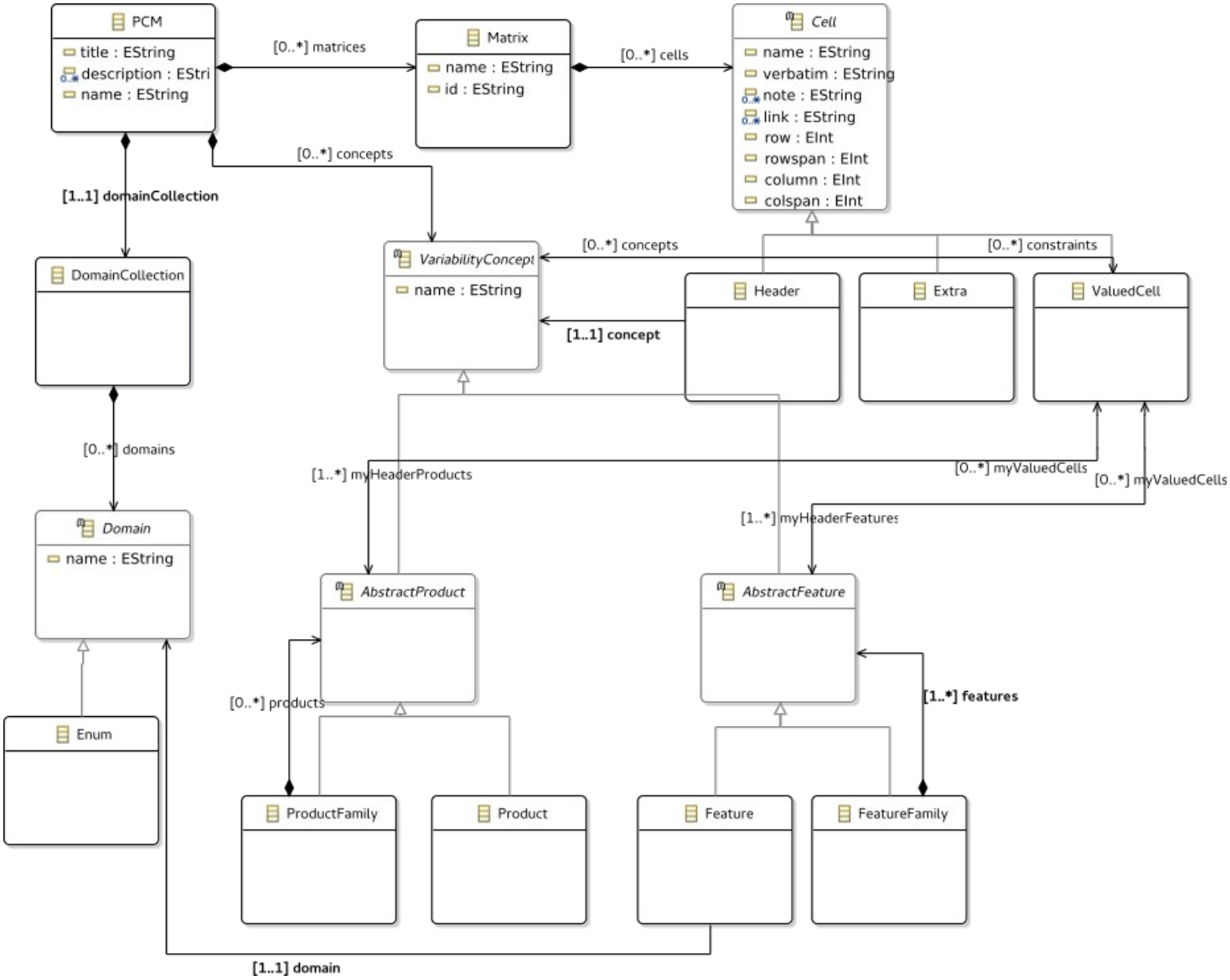
expert reviews, or even general product comparison materials. One common representation that can help to make a choice is to visualize all the products characteristics through a matricial representation, the so-called *Product Comparison Matrices (PCMs)* (see Figure 2 for an example).

The intrinsic *theoretical* good properties of such matrices are notably: (1) simplicity: no particular training is required to understand how it works; (2) synthesis: all the "expected"

ASE'14

- 3 objectives in mind
  - To propose a DSL for PCMs
  - To extract PCMs from Wikipedia
  - To provide displaying and edition facilities

First solution: a unique metamodel

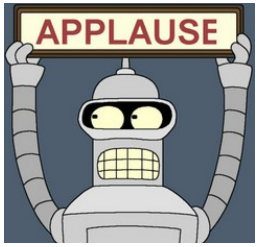


Evaluation of the first solution

- Experiment 1: validate the concepts of the metamodel
  - 20 researchers from DiverSE
- Experiment 2: implement a PCM editor
  - 1 researcher from DiverSE
- Experiment 3: implement an API for displaying and edition facilities
  - About 20 Master students enrolled in object-oriented design and development course
- Feedback while developing and teaching

Evaluation of the first solution

- Pros
  - Covers almost all concepts of the PCM domain
  - Hundreds of PCMs were successfully extracted from Wikipedia and encoded as PCM models.



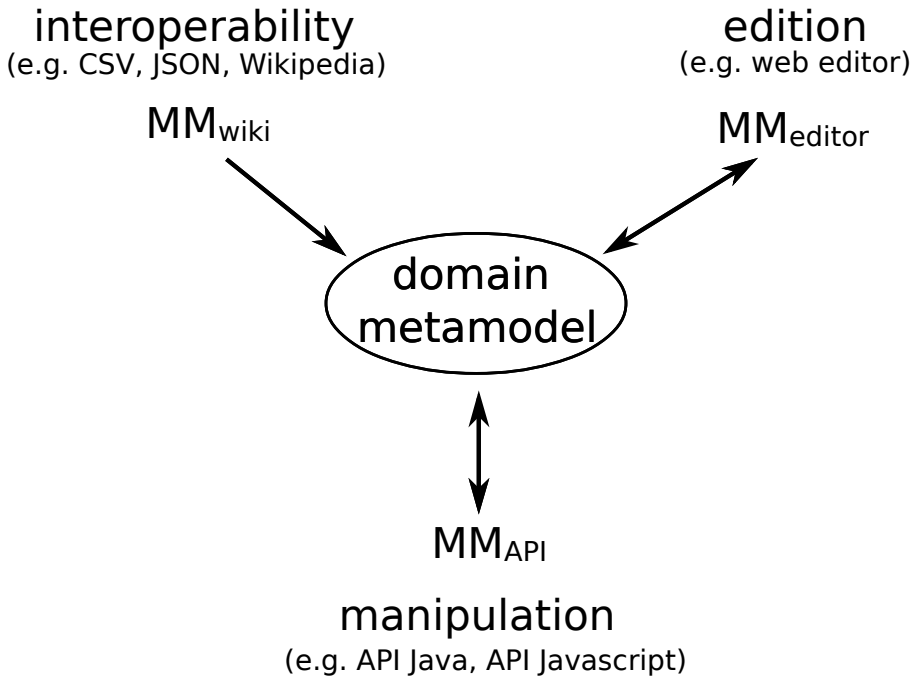
- Cons
  - Mix of concepts of products and features (PCM domain) with rows and columns (Wikipedia import or edition)
  - First step of the implementation of the editor: simplify the metamodel
  - Hard to navigate in a model: the main concepts (product and feature) are hidden behind an abstract class and 2 composite patterns

RQ1

- What are these forces that influence the metamodeling process?
  - **Interoperability**: transformation between a PCM model and a set of external formats (e.g. Wikipedia or CSV)
  - **Edition**: ease of creation and edition of a PCM model
  - **Manipulation**: operations that one can perform over PCM models (e.g. merge, diff or computing statistics)

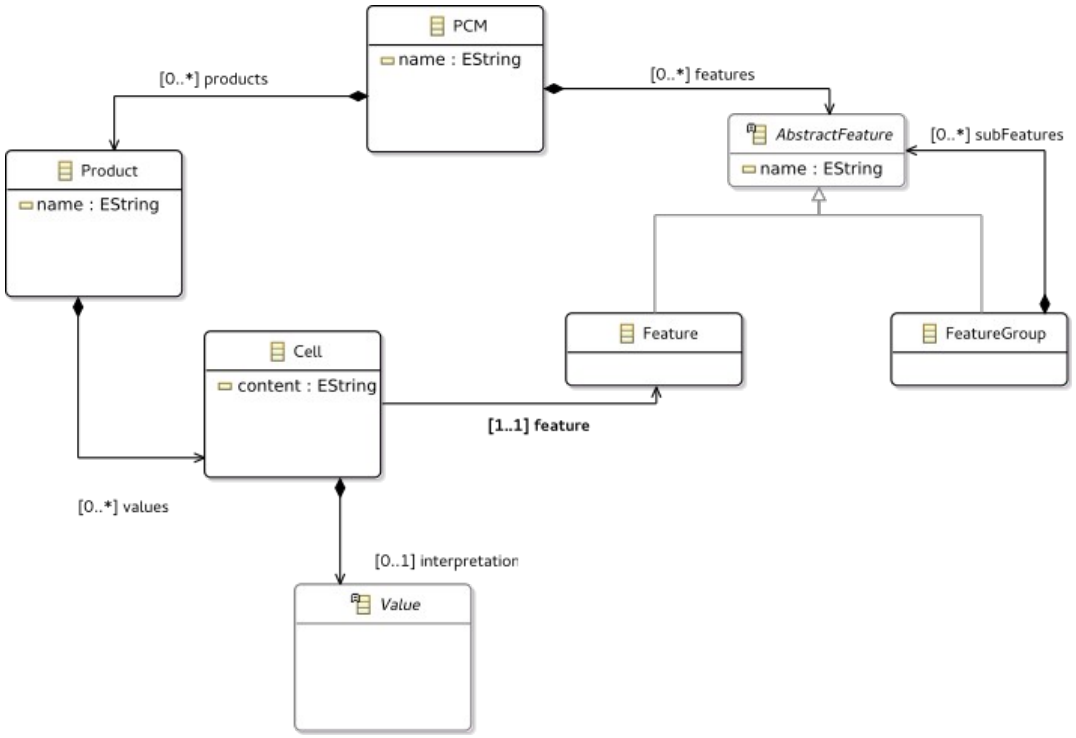
Second solution: multiple metamodels

- Domain metamodel: precisely represents the domain of PCMs
- Set of specialized metamodels dedicated to a particular force



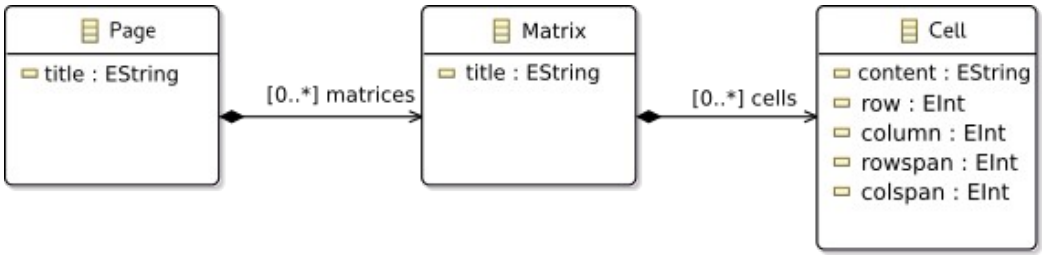
Domain metamodel

- Focus only on the PCM domain
  - No position (row, column) for the cells
  - Precise semantics
  - No redundant or unnecessary information



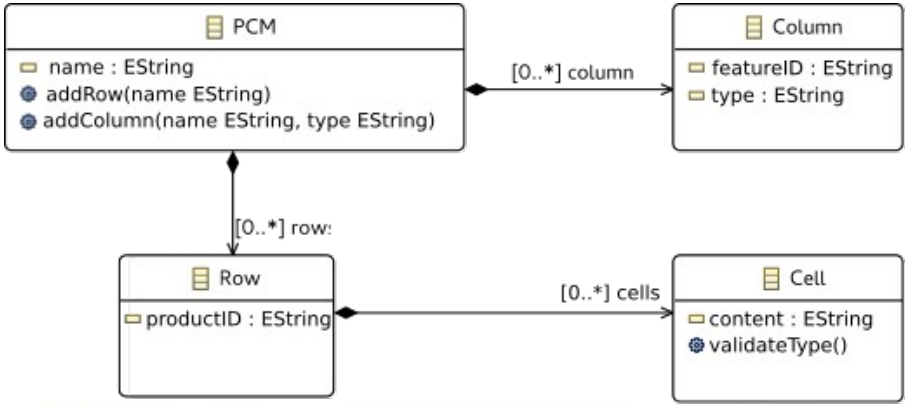
Force: Interoperability

- Two operators in Wikipedia syntax
  - Create row
  - Create cell
- Objective: reduce gap between Wikipedia syntax and the domain metamodel
- New metamodel which is close to the structure of a Wikipedia page



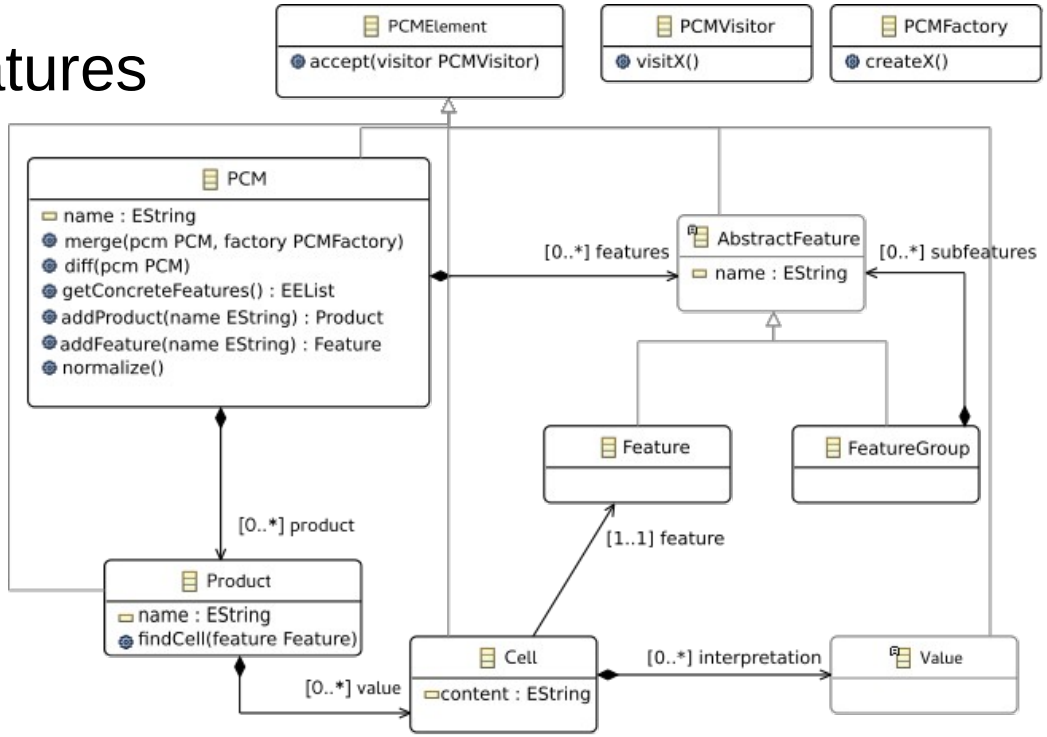
Force: Edition

- Objective: provide an online PCM editor
- The intuitive graphical notation of a PCM is a table
- … but the domain metamodel abstracts the tabular representation
- New metamodel for edition
  - Main concepts: rows, columns, cells
  - Specific operations for editing a PCM (add row, add column or validate type)



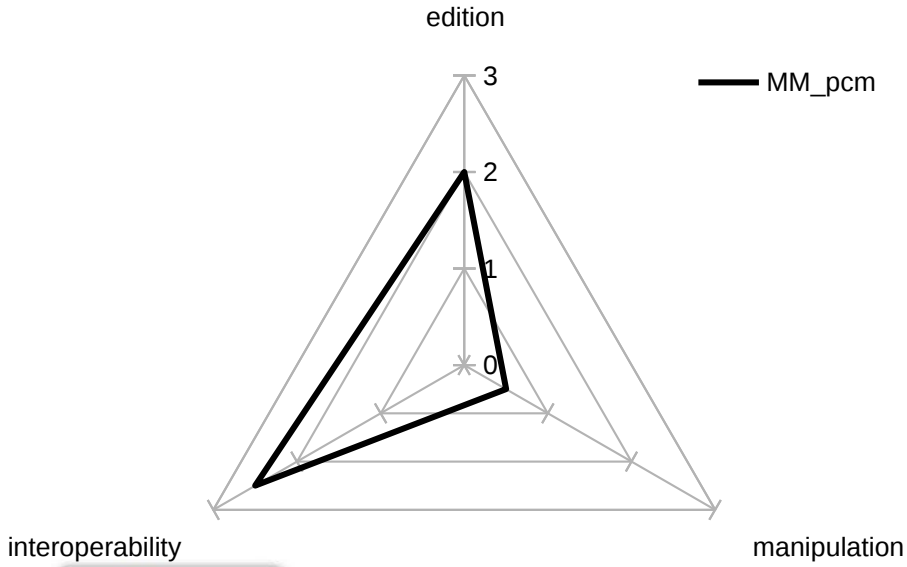
Force: Manipulation

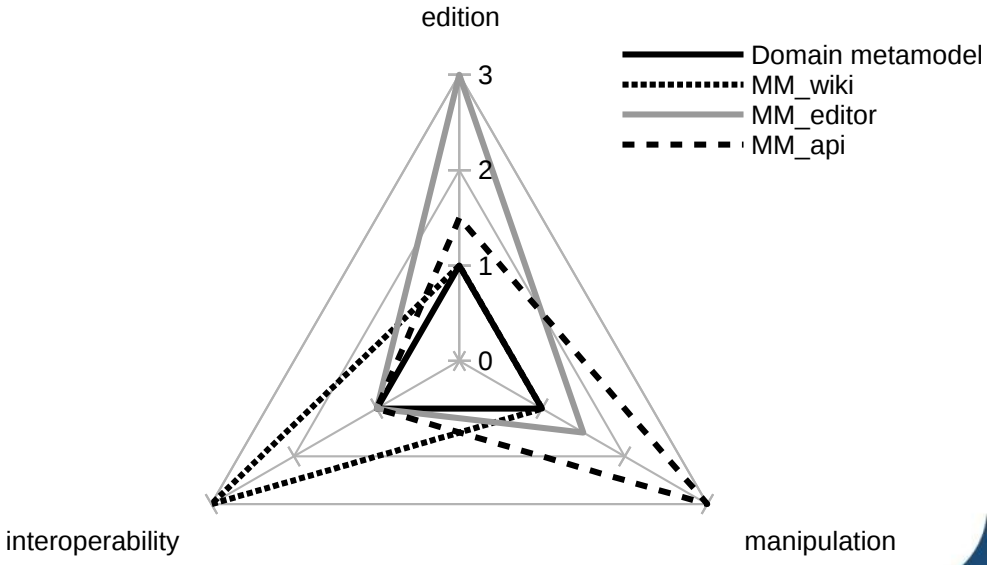
- Domain metamodel offers few operations for manipulating a PCM model
- Other metamodels offer task-specific operations
- New metamodel for manipulating PCMs with generic operations
  - Direct access to features
  - Visitor
  - Factory
  - Merge
  - Diff



RQ2

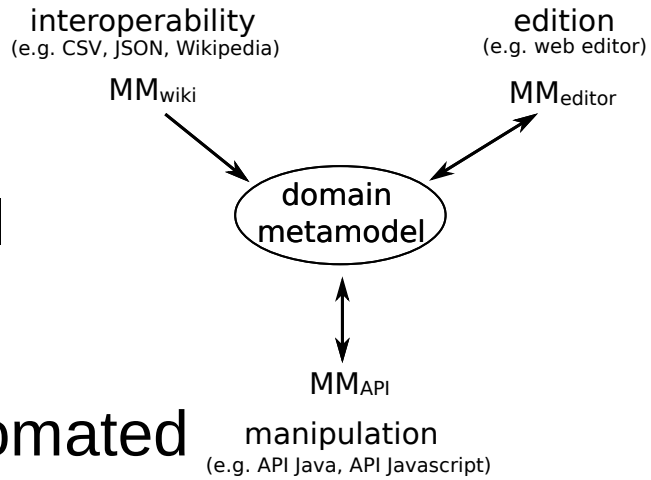
- Are there some conflicting forces?
  - Yes !
- Is a unique metamodel a suitable and feasible solution?
  - Our experience shows that having force-specific metamodel is beneficial for some forces
  - Hard to optimize all forces in one metamodel





RQ3

- How to relate the force-specific metamodels to the central domain metamodel?



- Interoperability ↔ domain metamodel
  - Semantic gap is huge
  - The transformation cannot be automated
- Edition ↔ domain metamodel
  - Mapping between feature/products and rows/columns
  - Automated transformation is possible
  - Automated derivation is possible from the domain metamodel with variability techniques (e.g. Clafer or CVL)

RQ3

- Manipulation ↔ domain metamodel
  - Simply adds operations
  - Automated transformation is possible
  - Automated derivation is possible with Aspect Oriented Modeling
- In some cases, the derivation of force-specific metamodels from the domain metamodel can be automated
  - Techniques (variability and AOM) that extend the basic object-oriented paradigm
- An automated derivation may not be possible

Open challenges

- **CH1:** Metamodeling as a multi-objective problem
  - When optimizing one specific force, there is a risk to degrade another

- **CH2:** On the limitations of object-oriented paradigm
  - Variability or aspect oriented techniques
  - Multiple separated models

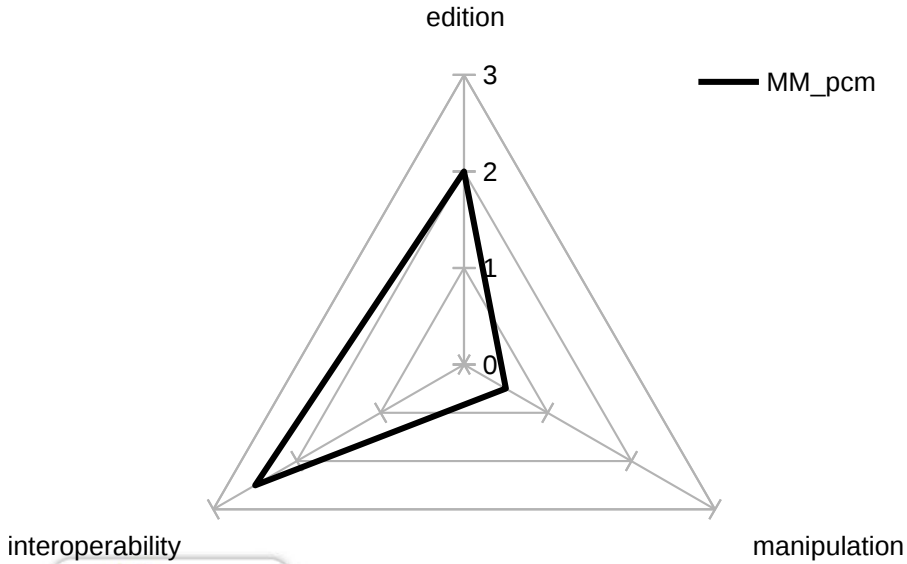
Open challenges

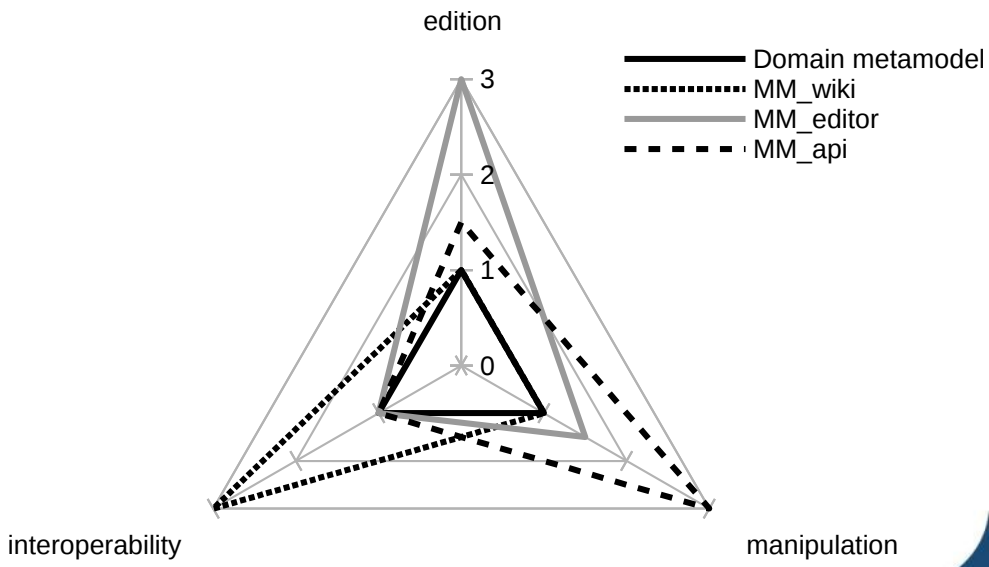
- **CH3:** Is a unique metamodel better than several?
  - Unique MM: harder to focus on several forces when metamodeling
  - Multiple MMs: synchronization problem

- **CH4:** Evaluating metamodels
  - How to measure cognitive dimensions (e.g. understandability or productivity)?
  - A precise framework would help to assess the fitness of a MM to a given force and justify the design of a new MM

Playground

- OpenCompare can act as a playground for addressing these challenges
- All metamodels are accesible at opencompare.org, github and ReMoDD





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