Multi-level modeling with MELANEE
A Contribution to the MULTI2018 Challenge

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The Challenge

- model a bicycle shop in a multi-level fashion
- fulfill requirements, if necessary with the help of a constraint language
- solve some particular problems in the multi-level modeling domain
- showcase strengths and weaknesses of different multi-level modeling approaches
The MELANEE tool

- supports a deep dialect of MLM
  - OCA (Orthogonal Classification Architecture)
- deep instantiation
  - potency
  - strict
    - no leap potency etc.
- UML-like look and feel (LML)
  - graphical
Level-Spanning Content

- **Linguistic Meta-models**
  - LML (Level-Agnostic Modeling Language)
  - deep OCL variant

- **Enumeration Types**
  - “Material”
  - “CyclistSize”

- **Constraint**
  - PAN-1
Isonyms vs. Hyponyms

PAN-Level Constraints

- ensuring the strictness of MELANEE
  - only isonymic instantiation

- context is the DeepModel and allows for a reflective query for a specific linguistic type

context DeepModel
inv PAN-1: Clabject -> forall(select(c|c.#getFeature()# -> select(f|f.#getDurability()# > 0)) -> size() = self.getDirectInstances() -> select(c|c.#getFeature()#) -> size())
- basic concepts related to customers/products
  
  context Product::revenue:Real (1,2) 
  derive O₃: self.allInstances() -> select(c|c.#getPotency()# = 0) -> 
  select(c|c.Invoice.date.substring(7,10) = "2017") -> 
  collectNested(Invoice.price)->sum()
Bicycle Categories - O₁

- product categories
- exploits durability and mutability of attributes
- invariant constraints for the lower levels

context BicycleConfiguration

inv O₁-wheelSize: self.frontWheel.size = self.rearWheel.size
Bicycle Configurations Level - $O_2$

- ChallengerA2XL configuration level
- all invariant constraints must hold here
Bicycle Instances - $O_3$

- ChallengerA2XL instance
- Invoice is read-only
- all invariant constraints must hold here
Example: OCL derivation

Defined on level $O_0$:

```
context Product::revenue:Real (1,2)
derive $O_{0.3}$: self.allInstances() ->
select(c|c.#getPotency()# = 0)
  -> select(c|c.Invoice.date.
             substring(7,10) = "2017")
  -> collectNested(Invoice.price)
  -> sum()
```

- allInstances different for each context
- date is not a data type but a string
Strengths of the model

- clabject duality and durability/mutability
  - allow an attribute abstraction to store different data for different but related context
    - e.g. revenue, averageRegularSalesPrice

- reflective and level aware/spanning constraints
  - e.g. enforcing strictness, top seller constraint

- Linguistic and ontological classification
  - allows non-ontologically typed clabjects
    - e.g. ProfessionalRaceFrame
Weaknesses of the model

- redundant instantiation of clabjects
  - e.g. Invoice, Customer
- PeterParker (as CategoryManager) clabject cannot be a Customer
- BicycleCategory clabject (O₁) is actually an abstract clabject, but has to be typed as Product → potency “2” instead of “0”
Hyponymic instantiation

- **Isonym without an ontological type**

<table>
<thead>
<tr>
<th>Frame²:Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>height²:Real = 1</td>
</tr>
<tr>
<td>size²:Real = 1</td>
</tr>
<tr>
<td>usn²:String = 2</td>
</tr>
<tr>
<td>weight²:Real = 1</td>
</tr>
<tr>
<td>colour²:String = 2</td>
</tr>
</tbody>
</table>

- **Hyponym with an ontological type**

<table>
<thead>
<tr>
<th>ProfessionalRaceFrame²:Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>material²:MATERIAL</td>
</tr>
<tr>
<td>topTubeLength²:Integer</td>
</tr>
<tr>
<td>downTubeLength²:Integer</td>
</tr>
<tr>
<td>seatTubeLength²:Integer</td>
</tr>
<tr>
<td>height²:Real = 1</td>
</tr>
<tr>
<td>size²:Real = 1</td>
</tr>
<tr>
<td>usn²:String = 2</td>
</tr>
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</tr>
<tr>
<td>colour²:String = 2</td>
</tr>
</tbody>
</table>

- **additional attributes**
Conclusion and Future Work

- completely covered all requirements
  - in a precise and concise way
- did not exploit the MELANEEs DSL features
- in the future:
  - Make MELANEE more flexible
    - Allowing multiple modes of conformation (eg. strict isonymic/hyponymic)
  - Enhance MELANEE with TREACL
    - Transformation, Reason, Enquiry, Action, Constraint – Language
Thank You!