Multilevel Behavioural Metamodelling

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Fernando Macías, Adrian Rutle, Volker Stolz Multilevel Behavioural Metamodelling

Why Modelling?



Pros

- \checkmark High reliability
- ✓ Mature (meta)modelling ecosystems
- \checkmark Good tool coverage



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Cons

- $\times~$ Mixed abstraction levels
- $\times~$ Synthetic typing relation
- \times Convoluted







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- $\checkmark~$ Unbounded number of levels
- ✓ Deep hierarchies (potency)
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- \times Technology lock-in

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"There is still no clear consensus on what the paradigm actually entails and how it should be applied"

MULTI 2016 CfP

Multilevel approaches

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Common realization of MLM: Clabject



Adapted from: Melanee Project - https://melanee2.informatik.uni-mannheim.de/confluence/

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Issues × Requires a linguistic metamodel × Every element peeds a linguistic type

- imes Every element needs a linguistic type
- $\times\,$ Synthetic typing and flattening of the ontological stack
- $\times~$ Custom tools and representations

Our realization of MLM: MultEcore



Our realization of MLM: MultEcore





Our realization of MLM: MultEcore



MultEcore tool



Applications – Behavioural metamodelling



Applications – Runtime Verification



Macias et al. Integration of Runtime Verification into Metamodeling for Simulation and Code Generation. RV 2016

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- Metamodelling hierarchy is based on typed graphs and graph homomorphisms.
- Potencies for deep characterization supported by allowing the typing relation to "jump" over levels.

For $j \ge k > i \ge 0$

Typing morphism from graph G_k at k to graph G_i at i is defined as

$$T_{k,i}: D(T_{k,i}) \rightarrow G_i$$

Direct mappings $x \in G_k \mapsto ty(x) \in G_{k-df(x)} \mapsto ty^2(x) \in G_{k-df^2(x)}$

Conclusions

- MultEcore, an alternative framework for multilevel modelling
- Applied to behavioural metamodelling and RV
- Tool as an Eclipse plugin, bypassing EMF's two-level limitation
 - Small learning curve
 - Mature ecosystem and toolset

Future Work

- New multilevel functionalities: navigation of typing relations
- Creation of a hierarchy of behavioural models
- Multilevel Coupled Model Transformations (Stay tuned!)

http://prosjekt.hib.no/ict/multecore/

Extra slides

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MEF representation for EMF



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Direct mappings $x \in G_k \mapsto ty(x) \in G_{k-df(x)} \mapsto ty^2(x) \in G_{k-df^2(x)}$

The type of $x \in G_k$ is $ty(x) = t \in G_{k-df(x)}$ where df(x) is the difference in "abstraction" levels between t and x, given by the potency on t. $ty^2(x) = ty(ty(x)), ty^3(x) = ty(ty^2(x)) = ty(ty(ty(x))), ...$ $df^2(x) = df(x) + df(ty(x)), df^3(x) = df^2(x) + df(ty^2(x)), ...$