

Collaborative alignment of heterogeneous design models

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Summary & Perspectives.

Complex systems

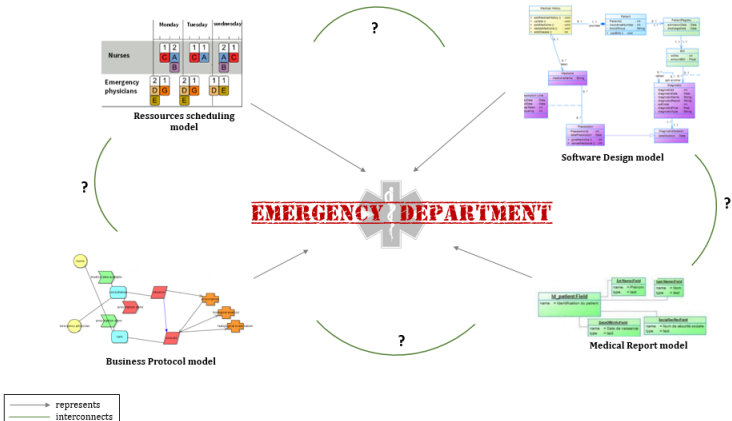
- ▶ A complex system involves interactions between different subsystems (Le Moigne, 1990).
- ▶ These subsystems are naturally heterogeneous (coming from different business domains - *viewpoints*).

Design of complex systems

- ▶ Complexity → Separation of concerns principle (Parnas, 1972).
→ Numerous business domains/DSLs/models...

Examples: Avionic/robotic/automotive systems, smart cities, emergency departments.

How to manage the whole system consistency??!



Challenge: Building a global view of an Emergency Department!!

Heterogeneous models matching

- Matching/Alignment: finding n-ary correspondences among semantically related concepts to face heterogeneity problems (Shvaiko & Euzenat, 2013).

Correspondence = Elements to link + Semantic Relationship.

Example: 

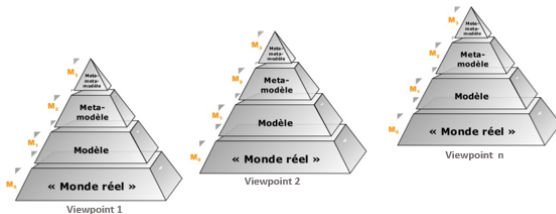
Semantic relationships definition (e.g. *Similarity*, *Aggregation*, *Deduction*, etc.) 

- A MDE approach to match models (two level mechanism) - AHM Gemoc'14 :(El Hamlaoui *et al.* , 2014)

AHM matching principle (El Hamlaoui *et al.* , 2014)

1. Defining meta-correspondences manually.

Meta-correspondence = a correspondence between meta-elements.

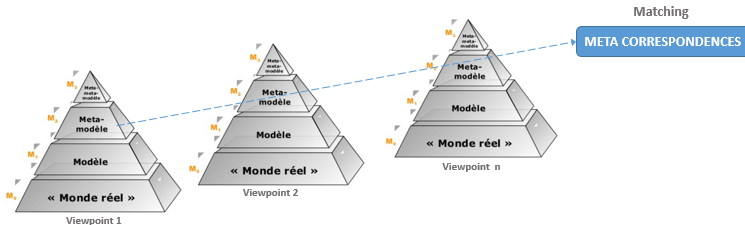


2. Propagating meta-correspondences: Reproducing them automatically at models level then keeping only those that

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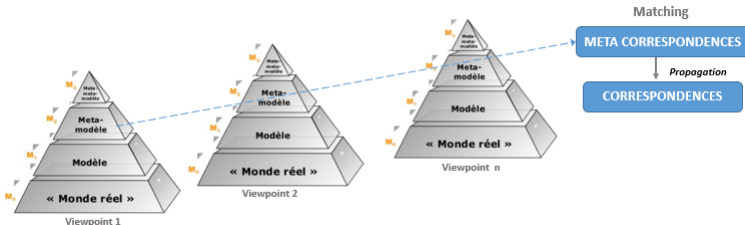


2. Propagating meta-correspondences: Reproducing them automatically at models level then keeping only those that verify the semantics of the relationship they use.

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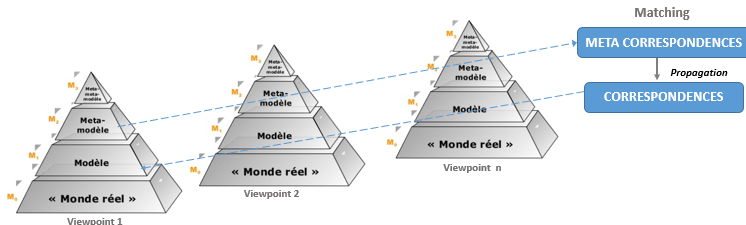


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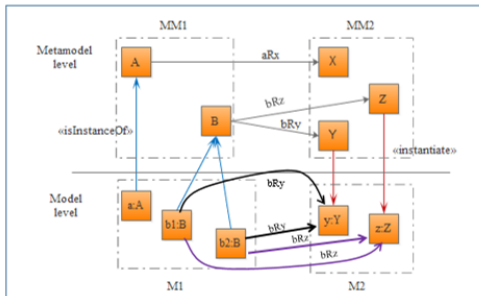
Meta-correspondence = a correspondence between meta-elements.



2. Propagating meta-correspondences: **Reproducing** them automatically at models level then **keeping only** those that verify the semantics of the relationship they use.

AHM matching principle (El Hamlaoui *et al.* , 2014)

M1C = Propagation (M2C) = Selection (Reproduction (M2C))



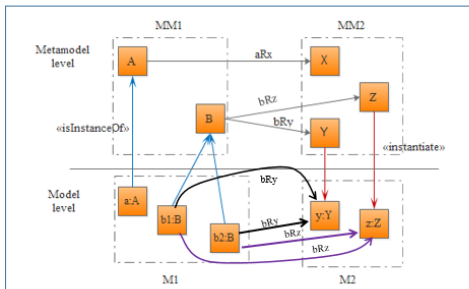
aRx , bRy , bRz : relationships.

M2C: model of meta-correspondences

M1C: model of correspondences.

AHM matching principle (El Hamlaoui *et al.* , 2014)

M1C = Propagation (M2C) = Selection (Reproduction (M2C))

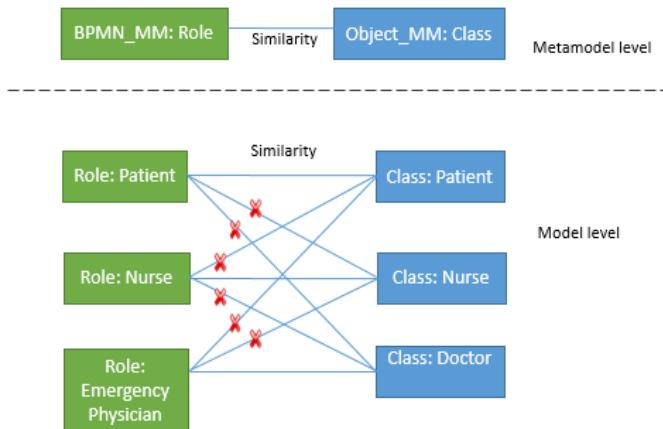


Filter correspondences by applying the semantics associated to the relationships they use

aRx , bRy , bRz : relationships.

M2C: model of meta-correspondences

M1C: model of correspondences.



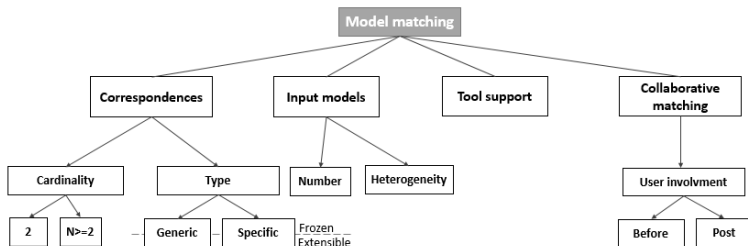
AHM hypothesis & limitations

- ▶ A centralized approach: one actor (expert)
- ▶ Expert:
 - ▶ full knowledge: Meta-modeling, Semantic relationships definition, Context and meaning of each meta-concept.

But... In real complex systems, such a role could not be found easily, due to the heterogeneity of needed expertise and the separation of concerns principle.

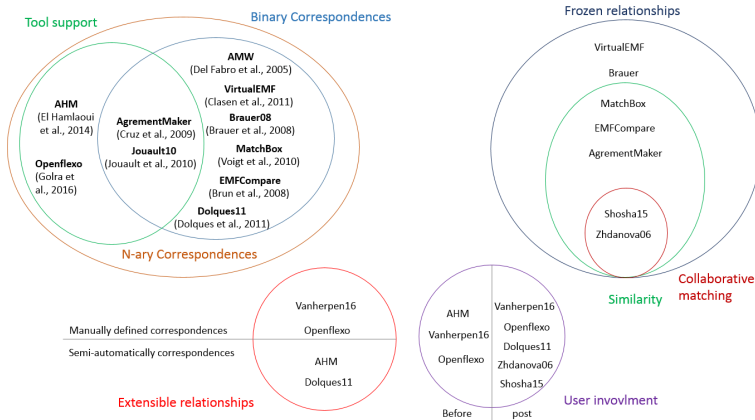
→ **The matching is rather a collaborative work than an individual one.**

Model matching approaches' classification



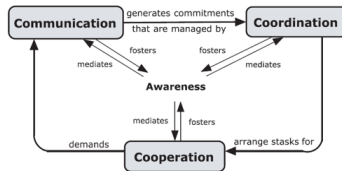
Model matching

details of model matching approaches' classification



Formalization of collaboration = Formalization of:

- ▶ Communication: Interlocutors targeting/Data exchange/Communication mechanisms (Lukosch & Schummer, 2008).
- ▶ Coordination: People and activities management (Kedji *et al.* , 2014)(Hawryszkiewicz, 2005).
- ▶ Cooperation: Group working on a shared space and having a common goal (Bonjour *et al.* , 2009).
- ▶ Group decision-making : Strategies choosing/GDM models (Canovas & Cabot, 2013)(Rockwell *et al.* , 2009).



Types of semantic relationships

- ▶ Causality (Barker & Szpakowicz, 1995) (Bethard *et al.* , 2008) (Chang & Choi, 2006).
- ▶ Influence, possession, entailment, purpose, temporal (Moldovan *et al.* , 2004).
- ▶ Part-whole (Artale *et al.* , 1996)(Girju *et al.* , 2006).
- ▶ ...

Overview

- ▶ Collaboration/Collaborative activity.
- ▶ Formalization of GDM.
- ▶ Decision strategy choosing.
- ▶ Tracing proposals, their associated solutions and evaluations.
- ▶ Definition of a concrete graphical syntax for MMCollab.

SPEM



Activity
(individual)



Work Product (WP)



Composite
role

CMSPEM



Actor

Purely MMCollab



Collaboration



Proposal
WP



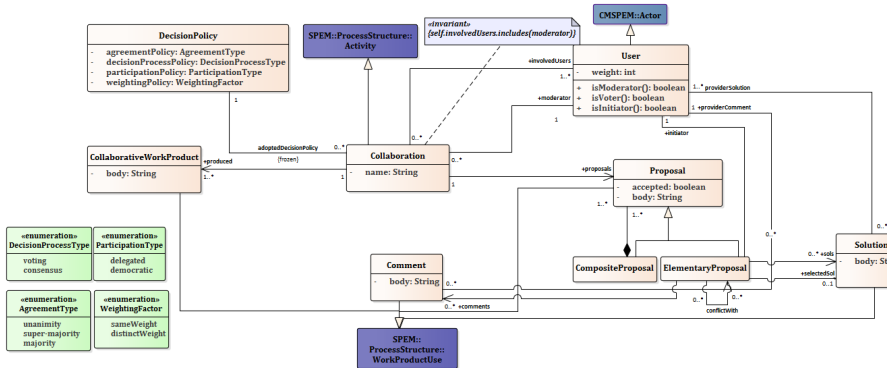
Solution
WP



Collaborative
WP

MMCollab: A metamodel of collaborative decision-making

Details of MMCollab



Principle

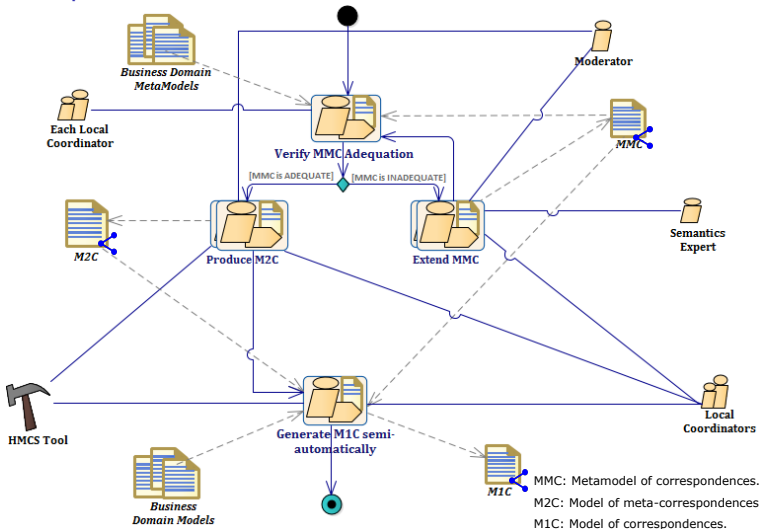
- ▶ Instantiation of MMCollab for matching purpose.
- ▶ Two levels matching mechanism in a collaborative way.

Involved actors

- ▶ A local coordinator for each design team. He represents his team and manages the model associated to his team's viewpoint.
- ▶ A semantics expert who is responsible for implementing the newly defined relationships on the tool.
- ▶ A Moderator who manages the collaboration by picking the best decision policy.
- ▶ A software tool HMCS to perform automatic tasks.

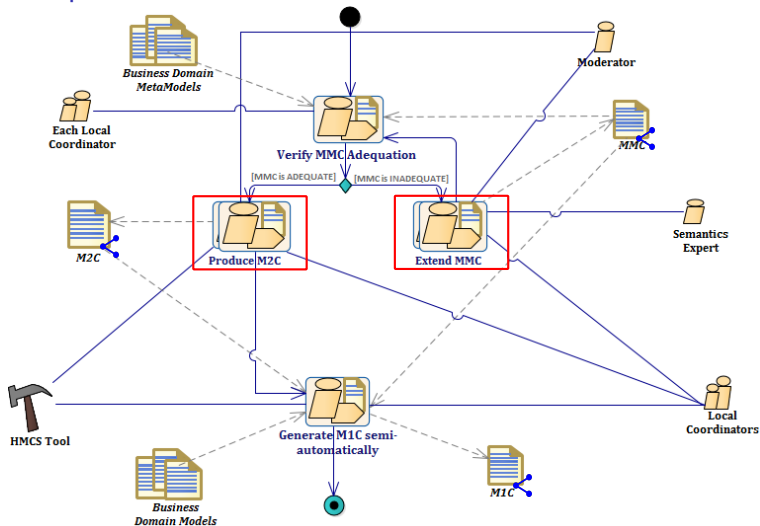
A collaborative heterogeneous models matching process

Global process

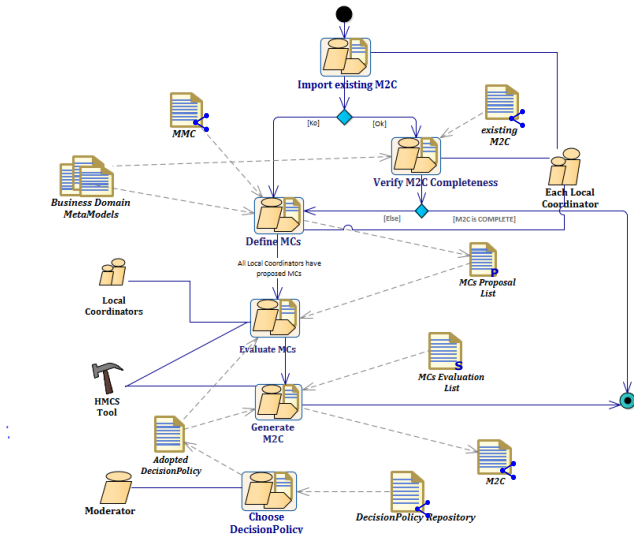


A collaborative heterogeneous models matching process

Global process

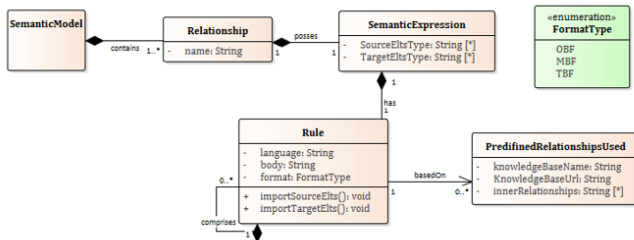


Detailed activity Produce M2C detailed



Semantic relationships definition

- A DSL for relationships semantics expression.



Semantic relationships definition

- Relationship's semantics definition using knowledge bases (wordNet (Pedersen *et al.* , 2004), conceptNet (Liu & Singh, 2004)).

```

Relationship{
  Name: Similarity
  SemanticExpression{
    SourceEltsType: Any
    TargetEltsType: Any}
  Rule{
    Language: Java
    Body:....
    Format: OBF}
  PredefinedRelationshipUsed{
    knowledfeBaseName: WordNet
    InnerRelationships: Synonyms}
  PredefinedRelationshipUsed{
    knowledfeBaseName: ConceptNet
    InnerRelationships: Synonym}
}

```

```

Relationship{
  Name: Induction
  SemanticExpression{
    SourceEltsType: Any
    TargetEltsType: Any}
  Rule{
    Language: Java
    Body:....
    Format: OBF}
  PredefinedRelationshipUsed{
    knowledfeBaseName: ConceptNet
    InnerRelationships: HasPrerequisite,
                        Entails}
}

```

CMS: Conference Management System

- ▶ 3 viewpoints designed by the same person: Object, Data persistence, Business process
- ▶ Per viewpoint: $\simeq 15$ models elements / $\simeq 10$ meta-elements.
- ▶ Binary correspondences.
- ▶ Evaluation Process: Centralized approach vs Collaborative (performed by PhD Students).
- ▶ Metrics: precision, recall, f-measure, coverage, time.
- ▶ Evaluation Results: Almost similar results (centralized vs collaborative one).
- ▶ Analysis:
 - ▶ Viewpoints are slightly heterogeneous.
 - ▶ Data dictionaries are very close.
 - ▶ CMS is a widely known system.

ED: Emergency Department

- ▶ 3 viewpoints designed by separate teams: Object, Business process, mock-up (El Hamlaoui *et al.* , 2016).
- ▶ Per viewpoint: $\simeq 40$ models elements / $\simeq 10$ meta-elements.
- ▶ Binary correspondences so far.
- ▶ Evaluation Process: Centralized approach vs Collaborative one (performed by PhD Students).
- ▶ Metrics: precision, recall, f-measure, coverage, time.
- ▶ Evaluation Results: Better results in the collaborative approach.
- ▶ Analysis:
 - ▶ Viewpoints are more heterogeneous than CMS case study.
 - ▶ Used Data dictionaries are not close (different designers).

Achieved

Heterogeneous models collaborative matching process.
Some semantic relationships definition.

Ongoing work

Consistency management of the model of correspondences in case of models evolution.
A HMCS tool version supporting collaboration.

Current challenges

Scalability in case of large systems, real business actors.
Satisfaction & collaboration (real business actors).
Semantic relationships accuracy & their applicability for various application domains.

Accepted:

Saloua Bennani, Mahmoud El Hamlaoui, Mahmoud Nassar, Sophie Ebersold and Bernard Coulette. ***"Collaborative model-based matching of heterogeneous models"***. CSCWD 2018. Nanjing, China.

Mahmoud El Hamlaoui, Saloua Bennani, Mahmoud Nassar, Sophie Ebersold and Bernard Coulette. ***"A MDE approach for heterogeneous models consistency"***. ENASE 2018. Madeira, Portugal.

Submitted for review:

Saloua Bennani, Mahmoud El Hamlaoui, Sophie Ebersold, Mahmoud Nassar and Bernard Coulette. ***"Collaborative process for matching heterogeneous models"***. ECSCW 2018. Nancy, France.

Saloua Bennani. ***"Towards a collaborative matching approach to relate sustainable cities design models"***. ESOF 2018. Toulouse, France.

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