Towards Ontology-driven Requirements Engineering (ODRE)

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Deficiencies of Current RE Methods

- Relationships among requirements are inadequately captured
- Requirement problems (e.g. conflicts, incompleteness) are detected too late or not all
  - Causal relationship between consistency, completeness and correctness [Zowghi2002]
  - Completeness and consistency are not verified
- Models for RE need richer and higher-level abstractions (goals, problems) [Mylopoulos1999]
Use of Reasoning for RE

- Support Goal-oriented RE (GORE)
  - Provide metamodel with a huge set of relevant metadata and requirement relationships
  - Provide meaningful checks for completeness and consistency
  - Specific suggestions to repair inconsistencies and incompleteness
GORE – Tbox
Goal-Oriented RE (Motivation Example)

<Goal>
Win the game

<Objective>
Goal

<Obstacle>
Fouls

<Obstacle>
aggressive Fans

<Decision>
Neuer as goalkepper

<Use-Case>
Nowotny backs Schweinsteiger

<Misuse-Case>
Red card for a player

<Scenario>
1st. Half time offensive play

<FR>
Early attack

<NFR>
Fast and good backing

<NFR>
Good concentration

<Constraint>
max. play time

<Decision>
Early exhaustion

<Risk>
Early exhaustion

<FR>
Attack until 10th. minute

<NFR>
Keeps 90% of the goals
Reasoning for RE - Architecture

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Towards Ontology-driven RE 6
Reasoning for RE – Completeness Check

- E.g. “Every Functional Requirement (FR) must define whether it is mandatory or optional.”
- GORE needs
  - 46 rules
  - Implemented as SPARQL queries
  - Requirements Model deemed incomplete if specific rule fails
  - Closed World for negation as failure supported by SPARQL 1.1 and TrOWL reasoner
Reasoning for RE – Completeness Check (Example)

Every FR must define whether it is mandatory or optional.

If FR is NOT mandatory AND NOT optional

Then

print error: "You did not specify whether the following FRs are mandatory or optional: [FR_n]."

"Please specify whether these FRs are mandatory or optional."
Reasoning for RE – Completeness Check (Example)

Extract of individuals and relationships:

\[ \text{isRelatedTo(Goal2; UseCase7)} \]
\[ \text{NonFunctionalRequirement (NonFunctionalRequirement1)} \]
\[ \text{IsOptional(NonFunctionalRequirement1; true)} \]
\[ \text{FunctionalRequirement(FunctionalRequirement1)} \]

**Error.**
You did not specify whether the following FR are mandatory or optional:
FunctionalRequirement1. Please specify this attribute for the FR:
FunctionalRequirement1. Every FR must specify AT LEAST ONE requirement relationship.
GORE needs 6 consistency rules
- among requirement artefacts (valid relations between requirement artefacts)
- Based on a chosen subset of requirement artefacts
- Consistency rules encoded as DL axioms
- Instance specific error messages resulting from validation displayed by Guidance Engine
Reasoning for RE – Consistency Check (Example)

\( isExclusionOf\ (\text{Functional Requirement5}; \text{Functional Requirement7}) \)
\( \text{ChosenRequirement}\ (\text{Functional Requirement5}) \)
\( \text{ChosenRequirement}\ (\text{Functional Requirement7}) \)

\text{Error.}
The following requirements exclude others: FunctionalRequirement5.
Please choose one of the following options:

\text{Suggestion.}
Exclude the following requirements from the chosen requirement set: FunctionalRequirement5. \ OR
Find alternatives for: FunctionalRequirement5 or
Revise the requirement relationships of(FunctionalRequirement5, FunctionalRequirement7).
Evaluation

- Minor evaluations with available Use Cases
  - Problem: available requirement specifications do not provide sufficient information (much less than could be captured by ODRE)

- Primary evaluation within MOST Project
  - Capture all requirement artefacts
  - Detect all inconsistencies and incomplete metadata

- Main evaluation planned
Conclusion

- All Requirement artefacts and meaningful relationships can be captured within an Ontology Metamodel
- ODRE Approach detects **inconsistent** and **incomplete** requirements
- Specification of requirements uses OWA
  - Verification needs CWA
- First evaluation proves applicability for medium requirement specifications
Outlook

Further work concentrates on:
- Guidance
- Traceability
- Integration into Eclipse
References


Towards Ontology-driven RE

Metadata (requirements, goals, relationships, ...)

ABox
Consistency check of requirement selection (6 rules)

Excluding requirements must not be included in one set.

IF excluding requirements are included in one set
THEN print error: "The following requirements exclude Others: [R_n]."
"Please choose one of the following options:
Exclude the following requirements: [R_n],
Find alternatives for [R_n] or
Revise the requirement relationships of [[R_x, R_y],... ]."
Lamsweerde defines goals as "declarative statements of intent to be achieved by the system under consideration" [Lamsweerde2000]

Benefits of GORE:
- Goals provide a meaningful criterion for sufficient completeness of a requirement specification
- Specification of pertinent requirements
- Relationships between goals and requirements can help to choose the best one
- Concrete requirements may change over time whereas goals remain stable
- Goals drive the identification of requirements