A conceptual model to support the writing of structured requirements

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1 Introduction

Requirements engineering (RE) is essential for system design since incorrect or incomplete RE can lead to misunderstandings, gaps, and mistakes that can negatively affect projects. Higher-quality requirements can reduce errors. However, verification and validation (V&V) of requirements qualities is challenging. Writing Natural Language Requirements (NLR) represents a traditional approach to Requirements Engineering, emphasizing documentation, and commonly written in textual form by stakeholders. NLR often suffer from a lack of quality (ambiguity, consistency, incompleteness...) and their (manual) V&V require a lot of effort for expert review, even following guidelines from INCOSE (2015). Formalized Requirements represent a contemporary paradigm within RE, emphasizing the utilization of models. Their expression facilitates executable behaviours for computing machines. Within extensive sets of requirements, formal methods offer automation of V&V activities, mitigating human errors and subjective interpretations during reviews. Nonetheless, comprehension may pose a challenge for stakeholders lacking proficiency in domain-specific languages according to Bruel et al. (2019). Structured Requirements (Semi-Formalization) represent a pivotal intermediary stage between NLR and Formalized Requirements, aiming to strike a balance between stakeholder comprehension and ease of formalization. Contributions on structured requirements support a requirement syntax that includes placeholders for adding system elements with meaningful semantics. Current structured requirements approaches (Dick and Llorens, use system elements in isolation (e.g. function, interface, performance), lacking a comprehensive view of the system. As a result, the links between requirements, the system they specify, and the V&V are not connected. To restore this connection and enable a systematic verification of set of requirement qualities, next section will present a conceptual model instantiable in requirements writing pattern.

2 Methods

We propose a conceptual model for writing structured requirements (left side, requirement statement structure) concerning a system of interest (right side, system ontology). This model would serve as a basis for transitioning between semi-formalized and formalized requirements without requiring new human interpretation. Similarly, the resulting formal V&V of requirements based on system knowledge with regard to the system ontology can be facilitated. Fig. 1. offers a comprehensive depiction of the requirements statement structure and its interrelation with the system ontology. The interactions between the "System" and the "Requirement Statement" primarily encompass the following aspects: A "Requirement Statement" is associated with a "System"; An "Interface Statement" pertains to a "System Port"; A "Capability Statement" (the contractual obligation of the requirement) can be correlated with an "Object Flow," and/or a "Function," and/or an "Operational Scenario"; "Real Element" and "Desired Element" are interconnected with either a "Property" of the "System" or the "Context," or a "Mode" of the "System". Guided by the system ontology, the requirement statement incorporates interaction rules between objects. For instance, we apply this conceptual model to write performance requirements. Performance requirements add information about the quality expected from a function or object flow. The writing pattern for a performance requirement is a "Satisfaction Condition Statement" with the following elements :<Logical Operator> <Real Element> <Comparison Operator> <Desired Element>. Applying this pattern could result in the following requirement: *When mode is "in preparation", the coffee machine shall produce <with> <a cycle time> <inferior to> <30 sec> a drink <with> <a temperature> <of> <60°c>.*

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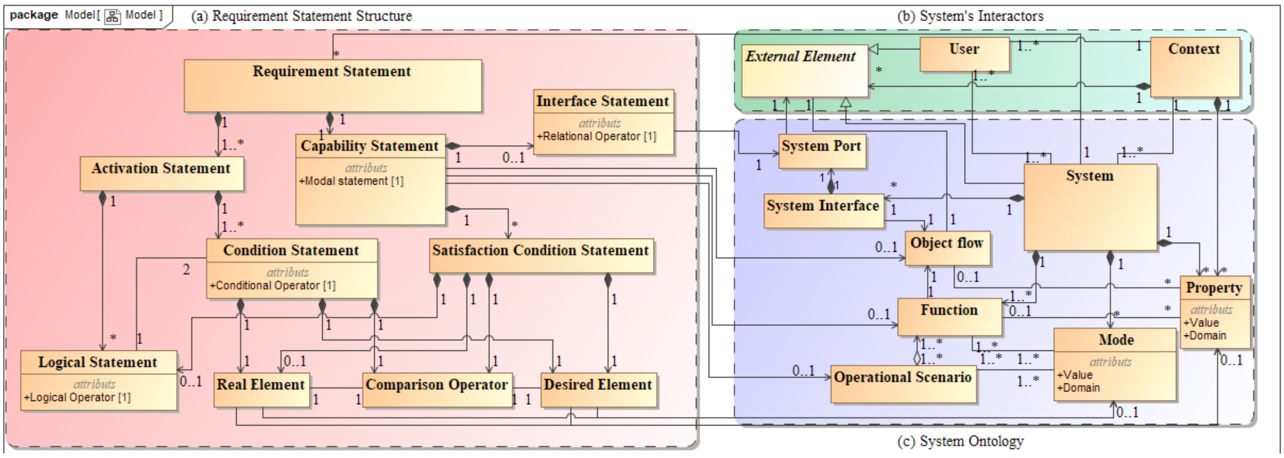

Figure 1: the requirement conceptual updated from Bacquet et al. (2024)

3 Results

We conducted analyses with existing approaches that aims to structure requirements. We studied the requirement structures proposed by different authors, and their ability to model the different types of requirements defined by Faisandier (2012). Then we performed a coverage calculation that compares the concepts present in the respective works with our model proposed by Bacquet et al. (2024). Thus, we demonstrated that the conceptual model we propose has a higher ability to model every type of system requirements than existing requirements structures. To illustrate the application of the requirements conceptual model, a verification of completeness was conducted for a set of requirements containing different requirement types.

4 Discussion

The proposed requirements conceptual model allows for the modelling of each type of system requirements, while existing literature only addresses a limited number of system concepts and requirement types. Future research will focus on translating structured requirements, based on this conceptual model, into formal requirements (using formal languages and tools) and on performing formal V&V on a set of system requirements.

References

Bruel, J.-M. et al. (2019) 'The role of formalism in system requirements (full version)', CEUR Workshop Proceedings, 2657(1), pp. 1–9. Available at: https://doi.org/10.48550/arXiv.1911.02564

Dick, J. and Llorens, J. (2012) *Using statement-level templates to improve the quality of requirements An Integrate white paper Using statement-level templates to improve the quality of requirements*.

Faisandier, A. (2012) Systems Opportunities and Requirements. Lulu.com, ISBN: 979–10–91699-01-3

INCOSE (2015) *Guide for writing requirements INCOSE TP-2010-006-02*. INCOSE Publications Office

Pohl, K. and Rupp, C. (2015) *Requirements Engineering Fundamentals: A Study Guide for the Certified Professional for Requirements Engineering Exam - Foundation Level - IREB compliant*. 2nd Edition.