What is essential? – A pilot survey on views about the requirements metamodel of reqT.org

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Abstract. [**Context & motivation**] This research preview presents ongoing work on the metamodel of a free software requirements modeling tool called reqT that is developed in an educational context. The work aims to make an initial validation of a survey instrument that elicits views on the metamodel of the reqT tool, which seek to engage computer science students in Requirements Engineering (RE) through an open source requirements engineering DSL embedded in the Scala programming language. [**Question**] The research question is: Which RE concepts are essential to include in the metamodel for a requirements engineering tool in an educational context? [**Principal ideas**] A survey instrument is developed with a list of 92 concepts (49 entities, 15 relations and 28 attributes) and a set of questions for each concept that elicit the respondents' views on the usage and interpretation of each concept. [**Contribution**] The survey is initially validated in a pilot study involving 14 Swedish RE scholars as subjects. The survey results indicate that the survey is feasible if the respondents is willing to invest around 30 minutes of their time. The analysis of the responses suggest that many of the concepts in the metamodel are used frequently by the respondents and there is a large degree of agreement among the respondents about the meaning of the concepts. Some terms can be viewed as "essential RE concepts" in that a many use them and agree on their meaning. The results are encouraging for future work on empirical validation of the relevance of the reqT metamodel.

Keywords: requirements engineering, metamodel, CASE tool, engineering education, embedded domain-specific language, empirical software engineering.

1 Introduction

There are many challenges in teaching Requirements Engineering (RE) [4,6], including conveying requirements modelling skills that can be used effectively in an unstructured, non-ideal, real-world situation [1]. When teaching RE modelling we may ask ourselves: What are the *essential* RE concepts that we should include in our taught metamodel for requirements? This paper investigates this questions in conjunction with the on-going work of developing a metamodel for reqT [9], an open source requirements engineering tool [7] used in RE education [8]. A survey instrument is presented aiming to elicit the frequency of RE term usage and the degree of interpretation agreement. The responses from 14 Swedish RE scholars are analysed and discussed and conclusions suggest that a large subset of the concepts of the current reqT metamodel can be argued to be "essential" in that a majority of the subjects use them while agreeing with the concept definitions. The presented work is an initial validation and further work involving more subjects is needed to provide conclusions with more certainty.

2 Background and Related Work

There are nowadays numerous commercial RE tools available, but many are expensive, complex and not sufficiently open [2]. A major aim of the reqT open source project is to provide a small but scalable, semi-formal and free software package for an educational setting [7] that can inspire code-loving computer science students to learn more about requirements modeling. The tool development started in 2011 at Lund University, where reqT is used in RE teaching at MSc level in the Computer Science & Engineering program [8].

A critical issue is how to choose the "essential" RE concepts that allows for sufficient expressiveness, while not overloading the metamodel with esoteric concepts just for the sake of completeness.

The reqT metamodel includes three types of concepts: entities, attributes and relations. Entities and attributes are nodes in a graph data structure, while relations are edges that can connect entities with sub-graphs. Thus a tree-like structure can be created of arbitrary depth spanning the graph that models some chunk of requirements.

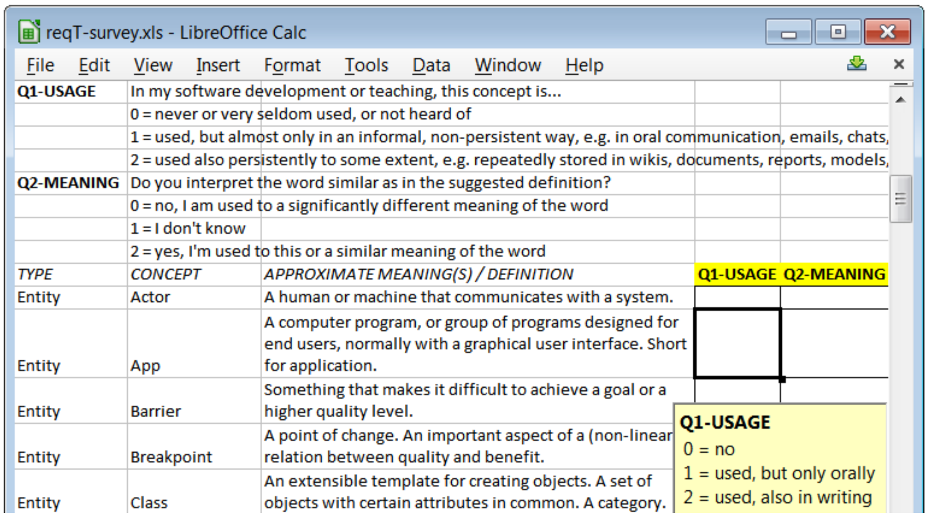
The code below shows a toy example of an orthogonal variability model [5] expressed in the reqT Scala-embedded DSL [7] illustrating a small part of its metamodel. Other parts of the metamodel contains concepts that enable e.g. goal modelling and use case and user story modelling, see further Appendix A.

```
Model(
  Component("apperance") has (
    VariationPoint("color") has (
      Min(0), Max(2),
      Variant("blue"), Variant("red"), Variant("green")),
    VariationPoint("shape") has (
      Min(1), Max(1), Variant("round"), Variant("square")),
    VariationPoint("payment") has (
      Min(1), Max(2), Variant("cash"), Variant("credit")),
    VariationPoint("payment") requires Variant("cash"),
    Variant("round") excludes Variant("red"),
    Variant("green") requires Variant("square")),
  Component("apperance") requires VariationPoint("shape"),
  App("free") requires Component("apperance"),
  App("free") binds (
    VariationPoint("shape") binds Variant("round")),
  App("premium") requires Component("apperance"),
  App("premium") binds (
    VariationPoint("color") binds (Variant("red"), Variant("green")),
    VariationPoint("shape") binds (Variant("round"), Variant("square")),
    VariationPoint("payment") binds Variant("cash")))
```

Entities are in bold, attributes in italics and relations start with a lower case letter. In the reqT editor, entities, attributes, and relations are syntax-coloured in blue, green and red respectively. A reqT model written in the above syntax is actually valid Scala code that, when executed, generates an immutable data structure that can be traversed and manipulated using Scala scripts. Also visualisations can be generated using GraphViz export and export to HTML and spreadsheet formats.

3 Methodology and Data Collection

In order to validate RE scholar's opinions of the metamodel a survey instrument is developed including 49 entities, 15 relations and 28 attributes of the reqT Version 3.0 metamodel. All the concepts are listed with their definitions in Appendix A.[1] These concepts and definitions were gathered from various sources including the IREB Glossary [2], wikipedia, terminology from agile development, variability [5] and goal modelling terminology, and the Lauesen text book [3] used in the RE course at Lund University [8], in which reqT is applied in student role-playing projects.


reqT-survey.xls - LibreOffice Calc
File Edit View Insert Format Tools Data Window Help

Q1-USAGE	In my software development or teaching, this concept is...			
	0 = never or very seldom used, or not heard of			
	1 = used, but almost only in an informal, non-persistent way, e.g. in oral communication, emails, chats,			
	2 = used also persistently to some extent, e.g. repeatedly stored in wikis, documents, reports, models,			
Q2-MEANING	Do you interpret the word similar as in the suggested definition?			
	0 = no, I am used to a significantly different meaning of the word			
	1 = I don't know			
	2 = yes, I'm used to this or a similar meaning of the word			
TYPE	*CONCEPT*	*APPROXIMATE MEANING(S) / DEFINITION*	**Q1-USAGE**	**Q2-MEANING**
Entity	Actor	A human or machine that communicates with a system.		
Entity	App	A computer program, or group of programs designed for end users, normally with a graphical user interface. Short for application.		
Entity	Barrier	Something that makes it difficult to achieve a goal or a higher quality level.		
Entity	Breakpoint	A point of change. An important aspect of a (non-linear relation between quality and benefit.		
Entity	Class	An extensible template for creating objects. A set of objects with certain attributes in common. A category.		

Q1-USAGE
0 = no
1 = used, but only orally
2 = used, also in writing

Fig. 1. A screen dump of a part of the survey instrument.

The data collection for the presented pilot run was made during a Swedish national network meeting with academic RE scholars in the spring of 2015. The survey was filled in during the meeting using the participants' own laptops in a downloadable spreadsheet as shown in Figure 1. The subjects were given 20 minutes to complete the survey. Most of the subjects handed in the survey via email directly after the session, while a few finshed it offline and emailed their response after the meeting.

4 Data Analysis

Subject background. The background questions in the survey regards the role of the subject, as shown in Table 1. In summary, the included[3] total number of subjects is 14, of which 10 are teachers, 10 are developers and 13 are researchers.

[1] The survey is available at `https://github.com/reqT/reqT/tree/3.0.x/survey`
[2] `https://www.ireb.org/en/cpre/cpre-glossary/`
[3] One subject answered NO on all background questions and was therefore excluded.

Table 1. Background of subjects, $N = 15$. The table use the subjects' anonymous ids S01–S15.

Background question	*Subject responding YES*
Do you teach software engineering and/or requirements engineering? YES/NO	S01 S03 S04 S05 S07 S08 S09 S11 S12 S14
Do you develop software by writing code and/or creating system models? YES/NO	S01 S02 S03 S07 S08 S09 S10 S11 S13 S14
Do you do academic research in software and/or requirements engineering? YES/NO	S01 S03 S04 S05 S06 S07 S08 S09 S10 S11 S12 S13 S14

Frequency analysis. The idea of ”essentiality” is characterized as the number of subjects that has responded that they (1) use the concepts at least in an informal or non-persistent way, *and* that they (2) use the concepts in a similar meaning as in the definition in Appendix A. Figure 1 shows the definitions of the three-level ordinal scales of Questions $Q1_{usage}$ and $Q2_{meaning}$ respectively. Table 2 shows the results of the frequency counts. If an ”essentiality threshold” is chosen at $N/2$ then only the 9 concepts from row $n = 7$ and below in Table 2 are considered ”non-essential”, hence showing that more than 90% of the metamodel concepts have a majority of the subjects that use and agree upon them. All concepts have at least one subject that use it and agree with the definition.

Table 2. Frequency analysis, where n is the number of subjects that for the respective concepts answered $(Q1_{usage} >= 1)$ *and* $(Q2_{meaning} = 2)$. In total there are 92 concepts (49 entities, 15 relations and 28 attributes). The higher up in the table, the more ”essential”.

n	*Entities*	*Attributes*	*Relations*
14	`Class, Component, UseCase, Variant`	`Comment, Example, Max, Min, Title`	`implements, verifies`
13	`Configuration, Data, Design, Event, Quality, Scenario, Stakeholder, System, Term`	`Code, Constraints, Cost, FileName, Probability, Profit, Spec, Why`	`excludes, interactsWith, is, relatesTo, requires`
12	`Actor, Domain, Feature, Function, Interface, Module, Relationship, Release, Req, Risk, Service, State, Task, Test`	`Benefit, Capacity, Frequency, Input, Order, Output, Prio, Text, Value`	`has, impacts`
11	`Idea, Label, Member, Meta, MockUp, Section, User`	`Image`	`precedes, superOf`
10	`Goal, Story`	`Expectation`	
9	`App, Issue, Target, WorkPackage`	`Damage`	`binds, helps`
8	`Item, Product, Resource, VariationPoint`		`deprecates`
7	`Breakpoint, Screen`	`Status`	
6	`Barrier`	`Deprecated`	`hurts`
5			
4	`Ticket`		
3			
2			
1	`Epic`	`Gist`	
0			

5 Discussion and Conclusion

It can be questioned if ”essentiallity” of a set of RE concepts can be characterized by how many RE scholars that use them. However, if someone use a certain concept and wants to model it, then the metamodel of the applied modelling approach needs to have it, in order for that person not to find that the metamodel is lacking vital parts. The presented survey is a pilot investigation with two main contributions: (1) the survey instrument and the data collection and analysis approach is feasible, and (2) for more than 90% of the metamodel concept there is a majority of the 14 participating RE scholars that use them and agree upon their definition.

Limitations. Due to the limited number of subjects and the high degree of homogeneity among subjects with respect to background, it is difficult to analyse and draw conclusions about potential differences in opinions between e.g. teachers and developers. Some subjects needed more time and completed their survey offline during the coming days, which may give a variation in how careful the responses were considered.

Further work. When developing a metamodel it is interesting not just to ask if the concepts to include are essential, but also to pose the question if is the set of concepts is complete. If some essential concept is missing from some stakleholder’s viewpoint, then the metamodel is not sufficient. With more subjects participating in the presented RE metamodel survey, the analysis of answers to further questions on alternative terms and missing concepts will be enabled and beneficial to the further development of a comprehensive and complete, but not overloaded, RE metamodel.

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8. Requirements Engineering course home page at Lund University: `http://cs.lth.se/ets170`, visited Oct 2015.
9. The reqT open source tool home page: `http://reqT.org`, visited Oct 2015.

Appendix A: Definitions of Metamodel Concepts

Entity	*Definition*
`Actor`	A human or machine that communicates with a system.
`App`	A computer program, or group of programs designed for end users, normally with a graphical user interface. Short for application.
`Barrier`	Something that makes it difficult to achieve a goal or a higher quality level.
`Breakpoint`	A point of change. An important aspect of a (non-linear) relation between quality and benefit.
`Class`	An extensible template for creating objects. A set of objects with certain attributes in common. A category.
`Component`	A composable part of a system. A reusable, interchangeable system unit or functionality.
`Configuration`	A specific combination of variants.
`Data`	Information stored in a system.
`Design`	A specific realization or high-level implementation description (of a system part).
`Domain`	The application area of a product with its surrounding entities.
`Epic`	A large user story or a collection of stories.
`Event`	Something that can happen in the domain and/or in the system.
`Feature`	A releasable characteristic of a product. A (high-level, coherent) bundle of requirements.
`Function`	A description of how input data is mapped to output data. A capability of a system to do something specific.
`Goal`	An intention of a stakeholder or desired system property.
`Idea`	A concept or thought (potentially interesting).
`Interface`	A defined way to interact with a system.
`Issue`	Something needed to be fixed.
`Item`	An article in a collection, enumeration, or series.
`Label`	A descriptive name used to identify something.
`Member`	An entity that is part of another entity, eg. a field in a in a class.
`Meta`	A prefix used on a concept to mean beyond or about its own concept, e.g. metadata is data about data.
`MockUp`	A prototype with limited functionality used to demonstrate a design idea.
`Module`	A collection of coherent functions and interfaces.
`Product`	Something offered to a market.
`Quality`	A distinguishing characteristic or degree of goodness.
`Relationship`	A specific way that entities are connected.
`Release`	A specific version of a system offered at a specific time to end users.
`Req`	Something needed or wanted. An abstract term denoting any type of information relevant to the (specification of) intentions behind system development. Short for requirement.
`Resource`	A capability of, or support for development.
`Risk`	Something negative that may happen.
`Scenario`	A (vivid) description of a (possible future) system usage.
`Screen`	A design of (a part of) a user interface.
`Section`	A part of a (requirements) document.
`Service`	Actions performed by systems and/or humans to provide results to stakeholders.
`Stakeholder`	Someone with a stake in the system development or usage.
`State`	A mode or condition of something in the domain and/or in the system. A configuration of data.
`Story`	A short description of what a user does or needs. Short for user story.
`System`	A set of interacting software and/or hardware components.
`Target`	A desired quality level or goal .
`Task`	A piece of work (that users do, maybe supported by a system).
`Term`	A word or group of words having a particular meaning.
`Test`	A procedure to check if requirements are met.
`Ticket`	(Development) work awaiting to be completed.
`UseCase`	A list of steps defining interactions between actors and a system to achieve a goal.
`User`	A human interacting with a system.
`Variant`	An object or system property that can be chosen from a set of options.
`VariationPoint`	An opportunity of choice among variants.
`WorkPackage`	A collection of (development) work tasks.

Attribute	*Definition*
`Benefit`	A characterisation of a good or helpful result or effect (e.g. of a feature).
`Capacity`	The largest amount that can be held or contained (e.g. by a resource).
`Code`	A collection of (textual) computer instructions in some programming language, e.g. Scala. Short for source code.
`Comment`	A note that explains or discusses some entity.
`Constraints`	A collection of propositions that restrict the possible values of a set of variables.
`Cost`	The expenditure of something, such as time or effort, necessary for the implementation of an entity.
`Damage`	A characterisation of the negative consequences if some entity (e.g. a risk) occurs.
`Deprecated`	A description of why an entity should be avoided, often because it is superseded by another entity, as indicated by a 'deprecates' relation.
`Example`	A note that illustrates some entity by a typical instance.
`Expectation`	The required output of a test in order to be counted as passed.
`FileName`	The name of a storage of serialized, persistent data.
`Frequency`	The rate of occurrence of some entity.
`Gist`	A short and simple description of an entity, e.g. a function or a test.
`Image`	(The name of) a picture of an entity.
`Input`	Data consumed by an entity,
`Max`	The maximum estimated or assigned (relative) value.
`Min`	The minimum estimated or assigned (relative) value.
`Order`	The ordinal number of an entity (1st, 2nd, ...).
`Output`	Data produced by an entity, e.g. a function or a test.
`Prio`	The level of importance of an entity. Short for priority.
`Probability`	The likelihood that something (e.g. a risk) occurs.
`Profit`	The gain or return of some entity, e.g. in monetary terms.
`Spec`	A (detailed) definition of an entity. Short for specification
`Status`	A level of refinement of an entity (e.g. a feature) in the development process.
`Text`	A sequence of words (in natural language).
`Title`	A general or descriptive heading.
`Value`	An amount. An estimate of worth.
`Why`	A description of intention. Rationale.

Relation	*Definition*
`binds`	Ties a value to an option. A configuration binds a variation point.
`deprecates`	Makes outdated. An entity deprecates (supersedes) another entity.
`excludes`	Prevents a combination. An entity excludes another entity.
`has`	Expresses containment, substructure. An entity contains another entity.
`helps`	Positive influence. A goal helps to fulfil another goal.
`hurts`	Negative influence. A goal hinders another goal.
`impacts`	Some influence. A new feature impacts an existing component.
`implements`	Realisation of. A module implements a feature.
`interactsWith`	Communication. A user interacts with an interface.
`is`	Sub-typing, specialization, part of another, more general entity.
`precedes`	Temporal ordering. A feature precedes (is implemented before) another feature.
`relatesTo`	General relation. An entity is related to another entity.
`requires`	Requested combination. An entity is required (or wished) by another entity.
`superOf`	Super-typing, generalization, includes another, more specific entity.
`verifies`	Gives evidence of correctness. A test verifies the implementation of a feature.