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Role of use case diagram in requirement analysis

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Abstract

Since its debut and acceptance as a de facto standard of the object-oriented paradigm, UML has received controversial reviews. The most controversial diagramming technique in UML is undoubtedly the Use Case diagrams. Some claim that Use Case diagrams do not play a valuable role in requirement analysis. Others argue that Use Case diagrams captured neither the static nor the dynamic aspects of the systems. The objective of this study is to investigate the role and value of Use Case diagrams in requirement analysis. We will investigate the information content of Use Case diagram and its role in requirement analysis.

Introduction

Requirement analysis is vital to systems development (Siau *et al*., 1997, Siau 1999). Robertson and Robertson (1999) wrote: "If you do not have the correct requirements, you cannot design or build the correct product and consequently, the product does not enable the users to do their work." Rolled out in the late 90's, UML has since emerged as the software industry's dominant modeling language. It is not only the de facto modeling language standard; but it is also fast becoming a dejure standard (Kobryn, 1999). UML, nevertheless, has its fair share of controversies (Siau & Cao 2001). Chief among the controversies is the Use Case diagram.

Use Case Diagram

According to Rosenberg and Scott (1999): "Within the UML, one of the early steps involves building a Use Case Model. The essence of this model is to capture user requirements of a new system, whether it is being developed from scratch or based on an existing system, by detailing all the scenarios that users will be performing." Bell and Schmidt (1999) argued that use cases are initialized as a method to capture primary functional objectives and touch upon other architectural views simultaneously with the motivation of establishing a system's architectural foundation, and subsequently supporting requirement coverage. Also, they emphasized the use cases' architectural ability to withstand potential shockwaves resulting from extreme requirements. In addition, they highlighted that the use case view serves not only as a vehicle to populate the other views with their associated artifacts, but also as a means to validate the software architecture for fidelity and completeness.

Cockburn (2001) stressed "use cases are popular largely because they tell coherent stories about how the system will behave in use… It becomes a communication device between the different stakeholders on the project." Rosenberg and Scott (1999) mentioned that use cases do more than get the dynamic model started – rather, they drive the dynamic model and, by extension, the entire development effort. Not surprising, Booch *et al.* (1999) emphasized that use cases are a powerful tool for identifying and capturing the system requirements. They argued that a use case provides an inventory of the kinds of interactions that can occur between users and a system, providing a forum for your domain experts, end users, and developers to communicate to one another.

Use case diagram, however, is also the most controversial diagramming technique in UML. Evans (1999) argued that use cases are not part of the design process -- implementation cannot be done on the basis of use cases solely, but analysis and design are needed in between. Also, Ambler (2000) proposed that Use Case diagrams are more suitable for upper management, and Evans (1999) decided that system developers that are typically characterized as linear thinkers tend not to be comfortable with the use case descriptions process. Therefore, Use Case diagrams are relatively more applicable and easily comprehended by the end users

in managerial roles while class diagrams make more sense to modeling experts. Dobing and Parsons (2000) also pointed out several problems related to use cases in UML. In addition, they questioned the very role of use case diagrams in UML, stating that UML is essentially a modeling language for object-oriented development, and concluding "there is little evidence about the extent to which it is appropriate as a language for modeling an application domain or system requirements."

In light of the controversies surrounding the Use Case diagram, a research to investigate the value and role of Use Case diagram in requirement analysis is undertaken. Since both Use Case and Class diagrams are usually the first two diagrams to be constructed when using UML, we will investigate the information content of Use Case diagram and Class diagram, and analyze the "value-added" information that is provided by the Use Case diagram.

Research Question

The fundamental question of interest is: to what extent do Use Case diagrams provide additional value to sufficiently and legitimately investigate a problem domain, and thus enhance analysis and design of the desired working system. This study shall address these research questions:

(i) Is there any synergy between Use Case diagrams and Class diagrams, i.e., does a combination of both models result in higher accuracy of the requirements analysis?

(ii) What information content from Use Case diagrams is absent from Class diagram and vice versa?

Theoretical Foundation

Problem space refers to the problem-solver's internal representation of the initial state, the goal state, intermediate problem states, and operators. Ernst and Newell (1969) and Simon (1978) have pointed out that the problem space is the set of all states (or all possible sequences of operators) that the problem solver is aware of. Applying the problem space theory to our case, we can argue that with either Class diagram or Use Case diagram alone, the problem space of a problem domain is broader. But, when either diagram is supplemented with the other diagram, more relevant information content is generated; and the problem space will naturally shrink and become more precise and definitive. This notion reduces the probability of making false problem-solving solutions but enhances the potential of deriving more accurate problem responses that are closely mapped to the desired working system. The hypothesis of this proposed study, reflecting the research questions presented above, is summarized here:

> H1: Subjects perform better in model understanding when both Use Case diagrams and Class diagrams are used than when either diagram is used alone.

Understandably, the notion that using a combination of two diagrams will provide a higher efficacy of model interpretation is justifiable. Yet, in addition to justifying the proposed hypothesis, qualitative study forms another objective of this research -- to qualitatively analyze and understand information content that is either present or absent in either diagram.

Research Design

The independent variable is the information model(s) (Use Case diagram, Class diagram, and both diagrams). The dependent variable is the subject's performance in interpreting the requirements represented in the information model(s). Performance is measured based on accuracy of interpretation. Siau *et al.* (1997) pointed out that an interpretation task is a task of considerable, though manageable, complexity and is reasonably within the range of analytic tools we have available from behavioral research. Furthermore, "because of the intrinsic importance of the task itself, and the tractable complexity of the task, studies on information model interpretation are a natural starting point in the behavioral study of information modeling" (Siau *et al.*, 1997).

Subjects will be selected from a pool of university students who have completed at least one UML modeling course. These subjects will be randomly assigned to the treatments. Each subject will be asked to interpret models (i.e., Use Case or Class diagrams or both) depicting two problem domains. For the first problem domain, the subject will either start with the Use Case diagram or the Class diagram. For the second problem domain, the subject will be presented with the Use Case diagram if s/he was presented with Class diagram in problem domain 1 and vice versa. This is to reduce possible bias and to prevent primacy effect.

Verbal protocol (Ericsson and Simon 1993), where subjects are asked to continuously verbalize their thought process, will be administered. Using this approach, subjects will be asked to think aloud as they generate their interpretation based on the treatment provided. The experimental session will be audio taped. Evaluation of responses by the subjects is twofold: 1) expert-judgment of subjects' understanding wherein transcripts of subjects will be analyzed and evaluated by two UML experts, and 2) self-reported understanding by subjects. Perceived usefulness and perceived ease-of-use questionnaires will also be used.

Discussion

In light of the controversy surrounding Use Case diagram in UML, this study attempts to offer empirical evidence to better understand the informational value of Use Case diagram in communicating and verifying requirements analysis. With a better understanding of Use Case and Class diagrams, this study also hopes to contribute to the future development of UML.

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