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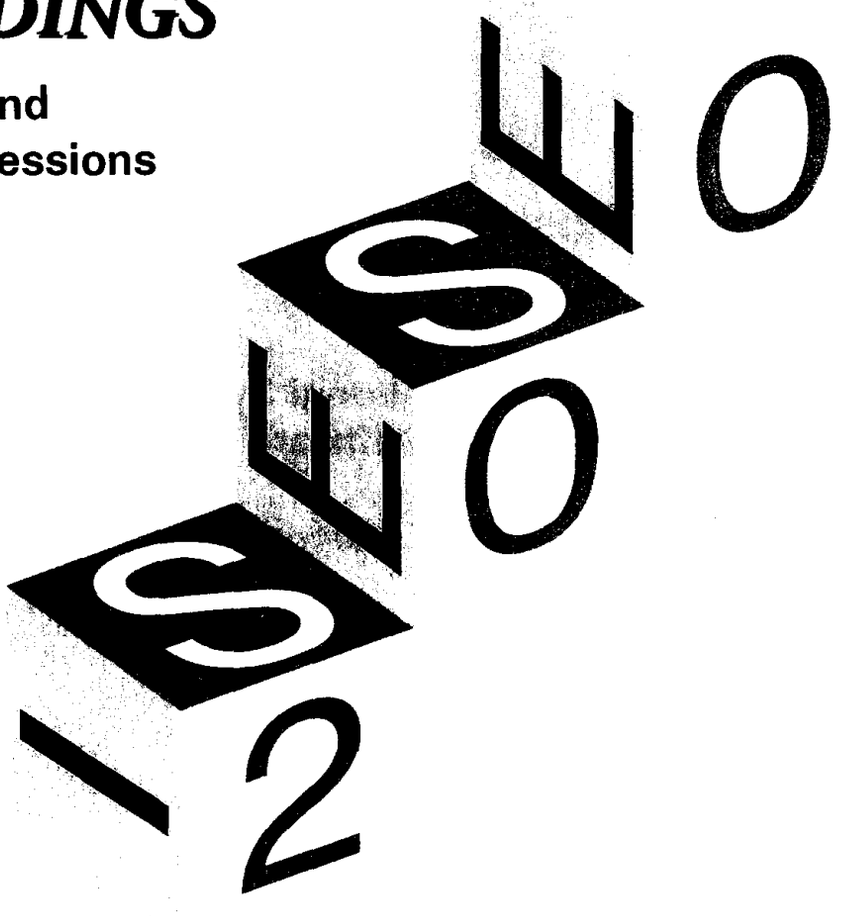

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Posters

A Controlled Experiment for Validating Metrics for OCL Expressions

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Abstract

The aim of this paper is to present a controlled experiment we have carried out in order to ascertain if any relation exists between two of the metrics we defined for OCL expressions, DN (Depth of Navigations) and NNC (Number of Navigated Classes), and two maintainability sub-characteristics: understandability and modifiability. We found that DN is highly correlated with the time the subjects spent on understanding and modifying OCL expressions.

1. Metrics for OCL expressions within UML/OCL models

It is widely recognized that the quality of UML models has a relevant repercussion in the software product that is finally implemented. This fact is corroborated by the huge amount of metrics that have been proposed in the literature which measures quality aspects of UML models. But, though UML has became the standard language of OO modeling, many design decisions, constraints and essential aspects of software systems cannot be expressed in a UML diagram [3], [8] through diagrammatic notations. This implies that the metrics defined until now will not be able to capture those design decisions (made early during software development) that cannot be expressed using only graphical notations. However, with the introduction of OCL [6] by OMG, the quality of a UML model can be improved specifying it in a combination of the UML and OCL languages, i.e., through a UML/OCL combined model. Without OCL expressions the model would be severely underspecified [8].

The lack of metrics for OCL expressions, motivated as to define as set of metrics for measuring the structural properties of OCL expressions which are specified within UML class diagrams [7], with the idea that could be useful indicators of the understandability and modifiability of OCL expressions. We hypothesized that OCL expression structural properties have an impact on the cognitive complexity of modelers, due to the fact that when developers try to understand an OCL expression (considered in our study as a single mental abstraction: a chunk) they apply cognitive techniques, such as "chunking" and "tracing" [2], [5]. High cognitive complexity leads to an OCL expression reducing its understandability, and this conduce to undesirable external qualities, such as reduced maintainability and increasing fault-proneness. For that reason, we have defined, following a consistent methodology [1], a set of metrics related to these cognitive techniques [7]. The main objective of this paper is the empirical validation of the following metrics: 1) NNC, which counts the total number of classifiers to which an expression navigates to, and 2) DN, defined as the maximum depth of the navigation tree.

2. A controlled experiment

The main goal of the experiment is to ascertain if any relation exists between the metrics DN and NNC and the understandability and modifiability of the OCL expressions. If such relation exists we will have found, to some extent, early indicators of OCL expressions understandability and modifiability. We have followed some suggestions provided by Wohlin et al. [9] and Juristo and Moreno [4] on how to perform controlled experiments.

Hereafter, we will briefly describe the main characteristics of the experiment:

- The subjects were fifteen students enrolled in the third-year of Computer Science at the Department of Computer Science at the National University of Comahue in Neuquén, Argentina.
- When the experiment was run the subjects were taking a course of 20 hours of OCL, which reveals that the subjects had low experience in OCL.

- The independent variables are two structural properties: length and coupling, measured by NNC and DN metrics. The dependent variables are the understandability and modifiability of OCL expressions within UML/OCL models, measured as "understandability time" and "modifiability time".
- The objects were four UML/OCL combined models, having each of them one OCL expression.
- We selected a within-subject 2x2 crossed factorial design (see table 1) , i.e., all the tests (experimental tasks) had to be solved by each of the subjects. The tests were put in a different order for each subject for alleviating learning effects.

Table 1. A 2X2 crossed factorial design

		DN	
		Low	High
NNC	Low	2,1 (G1)	2,3 (G3)
	High	4,1 (G2)	4,3 (G4)

- Each UML/OCL model had an enclosed test that included the following tasks:
  Understandability tasks: Consists of four questions about the meaning of the OCL expression within the UML/OCL model. These questions reflected whether or not they had understood each diagram. The first question asks the subject about navigations concepts, meanwhile the last three questions were a multiple choice about the meaning of the OCL expressions. Each question has three options, being only one option the correct answer. They also had to note how long it took to answer the questions. The understandability time, expressed in minutes and seconds, was obtained from that.
  Modifiability tasks: Each subject had to modify the OCL expression according to three new requirements. The modifications to each test were similar, including defining new navigations, attributes referred through navigations, etc.
- Moreover, they have to complete a debriefing questionnaire, which includes personal details and experience.
- The experiment was run in one session. The subjects were given all the materials previously described. We explained to them how to carry out the tests, asking for carrying out the test alone, and using unlimited time to solve it. There was an instructor who supervised the experiment and any doubt could be asked to him.

Analyzing the obtained data through an ANOVA, we can conclude that the depth of Navigation (DN) metric has a great influence on the time the subjects spent on understanding and modifying an OCL expression. Result that must be considered as preliminary. As future work, we will do a replication of the experiment with professionals and apply the metrics to "real projects" in order to increase the external validity of the results. Moreover, we will work in the generalization of the benefits of the set of metrics defined for OCL expressions, trying to obtain metrics at class and class diagram levels.

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