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Faculty of Computer Science Institute of Software and Multimedia Technology, Software Technology Group

A FAMILY OF ROLE MODELING LANGUAGES

Nathan Fillion
Born on: 01.01.1970 in Moscow

DISSERTATION

to achieve the academic degree

DOKTOR-INGENIEUR (DR.-ING.)

Referee
Robert Picardo

Supervising professors
Patrick Stewart
Leonard Nimoy

Submitted on: 30.9.2000

For my loving children

Statement of authorship

I hereby certify that I have authored this Dissertation entitled *A Family of Role Modeling Languages* independently and without undue assistance from third parties. No other than the resources and references indicated in this thesis have been used. I have marked both literal and accordingly adopted quotations as such. They were no additional persons involved in the spiritual preparation of the present thesis. I am aware that violations of this declaration may lead to subsequent withdrawal of the degree.

Dresden, 30.9.2000

Nathan Fillion

ABSTRACT

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

ZUSAMMENFASSUNG

Dies hier ist ein Blindtext zum Testen von Textausgaben. Wer diesen Text liest, ist selbst schuld. Der Text gibt lediglich den Grauwert der Schrift an. Ist das wirklich so? Ist es gleichgültig, ob ich schreibe: „Dies ist ein Blindtext" oder „Huardest gefburn"? Kjift – mitnichten! Ein Blindtext bietet mir wichtige Informationen. An ihm messe ich die Lesbarkeit einer Schrift, ihre Anmutung, wie harmonisch die Figuren zueinander stehen und prüfe, wie breit oder schmal sie läuft. Ein Blindtext sollte möglichst viele verschiedene Buchstaben enthalten und in der Originalsprache gesetzt sein. Er muss keinen Sinn ergeben, sollte aber lesbar sein. Fremdsprachige Texte wie „Lorem ipsum" dienen nicht dem eigentlichen Zweck, da sie eine falsche Anmutung vermitteln.

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PART I.

STATE OF THE ART

1. INTRODUCTION

Role Modeling Language (RML) is awesome (Kühn et al., 2014). Role Modeling Languages (RMLs) are even better (Kühn et al., 2014).

1.1. MOTIVATION

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

1.2. BACKGROUND

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

1.3. PROBLEM DEFINITION

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

1.4. OUTLINE

2. PREREQUISITES

2.1. FIRST ORDER LOGIC

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

2.2. FEATURE MODELING

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

2.3. LANGUAGE PRODUCT LINES

3. BACKGROUND

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

3.1. THE NATURE OF ROLES

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

3.1.1. BEHAVIORAL NATURE

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

3.1.2. RELATIONAL NATURE

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest

gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

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PART II.

SOLUTION

4. FORMAL ROLE-BASED MODELING LANGUAGE

4.1. FORMALIZATION

4.1.1. TYPE LEVEL

After introducing the ontological foundations and the graphical notation, we can introduce our formal model, starting on the type level. For brevity, we omitted the notion of *attributes* from these definitions. Nevertheless, the necessary additions are presented in the Appendix.

Definition 1 (Compartment Role Object Model). *Let NT, RT, CT, and RST be mutual disjoint sets of Natural Types, Role Types, Compartment Types, and Relationship Types, respectively. Then a* Compartment Role Object Model (CROM) *is a tuple $\mathcal{M} = (NT, RT, CT, RST, fills, parts, rel)$ where $fills \subseteq (NT \cup CT) \times RT$ is a relation, $parts : CT \to 2^{RT}$ and $rel : RST \to (RT \times RT)$ are total functions. A CROM is denoted* well-formed *if the following axioms hold:*

$$\forall rt \in RT\ \exists t \in (NT \cup CT) : (t, rt) \in fills \tag{4.1}$$

$$\forall ct \in CT : parts(ct) \neq \emptyset \tag{4.2}$$

$$\forall rt \in RT\ \exists! ct \in CT : rt \in parts(ct) \tag{4.3}$$

$$\forall rst \in RST : rel(rst) = (rt_1, rt_2) \wedge rt_1 \neq rt_2 \tag{4.4}$$

$$\forall rst \in RST\ \exists ct \in CT : rel(rst) = (rt_1, rt_2) \wedge rt_1, rt_2 \in parts(ct) \tag{4.5}$$

In detail, *fills* denotes that rigid types can play roles of a certain role type, *parts* maps compartment types to their contained role types, and *rel* captures the two role types at the respective ends of each relationship type. The well-formedness rules ensure that the *fills*-relation is surjective (1); each compartment type has a nonempty, disjoint set of role types as its parts (2, 3); and *rel* maps each relationship type to exactly two distinct role types of the same compartment type (4, 5).

Example 1 (Compartment Role Object Model). *Let $\mathcal{B} = (NT, RT, CT, RST, fills, parts, rel)$*

be the model of the bank, where the idividual components are defined as follows:

$$
\begin{aligned}
NT &:= \{\mathit{Person}, \mathit{Company}, \mathit{Account}\} \\
RT &:= \{\mathit{Customer}, \mathit{Consultant}, \mathit{CA}, \mathit{SA}, \mathit{Source}, \mathit{Target}, \\
&\quad\ \mathit{MoneyTransfer}\} \\
CT &= \{\mathit{Bank}, \mathit{Transaction}\} \\
RST &= \{\mathit{own\_ca}, \mathit{own\_sa}, \mathit{advises}, \mathit{trans}\} \\
\mathit{fills} &:= \{(\mathit{Person}, \mathit{Consultant}), (\mathit{Person}, \mathit{Customer}), \\
&\quad\ (\mathit{Company}, \mathit{Customer}), (\mathit{Account}, \mathit{Source}), \\
&\quad\ (\mathit{Account}, \mathit{Target}), (\mathit{Account}, \mathit{CA}), \\
&\quad\ (\mathit{Account}, \mathit{SA}), (\mathit{Transaction}, \mathit{MoneyTransfer})\} \\
\mathit{parts} &:= \{\mathit{Bank} \to \{\mathit{Consultant}, \mathit{Customer}, \mathit{CA}, \mathit{SA}, \\
&\quad\ \mathit{MoneyTransfer}\}, \\
&\quad\ \mathit{Transaction} \to \{\mathit{Source}, \mathit{Target}\}\} \\
\mathit{rel} &:= \{\mathit{own\_ca} \to (\mathit{Customer}, \mathit{CA}), \\
&\quad\ \mathit{own\_sa} \to (\mathit{Customer}, \mathit{SA}), \\
&\quad\ \mathit{advises} \to (\mathit{Consultant}, \mathit{Customer}), \\
&\quad\ \mathit{trans} \to (\mathit{Source}, \mathit{Target})\}
\end{aligned}
$$

The bank model $\mathcal{B}$ is simply created in four steps. First, all the natural types, compartment types, role types, and relationship types are collected into the corresponding set.[1] Second, the set of role types contained in each compartment type is assigned to the *parts*-function. Third, it is specified which natural type can *fill* which role type, and finally the *rel*-function is defined for the role types at the ends of each relationship type. Thus, CROMs can be retrieved from their graphical representation. The presented bank model $\mathcal{B}$ is well-formed, because each defined role type is filled by at least one natural type or compartment type (1), each compartment type consists of a non-empty (2) and disjoint (3) set of role types, and each relationship type is established between two distinct role types (4) of the same compartment type (5).

4.1.2. INSTANCE LEVEL

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5. FIRST FAMILY OF ROLE-BASED MODELING EDITORS

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RML Role Modeling Language

REFERENCES

Kühn, T., Leuthäuser, M., Götz, S., Seidl, C., and Aßmann, U. (2014). A metamodel family for role-based modeling and programming languages. In *Software Language Engineering*, volume 8706 of *Lecture Notes in Computer Science*, pages 141–160. Springer.