Research on the UML model consistency checking of user definition invariants

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Abstract

In this research, a practical and general-purpose system for syntactical consistency checking between diagrams of a UML model was devised and realized. In this system, users can define and check the invariants over an UML meta-model.

1 Backgound

Now, software development based on object-oriented methodology is briskly. UML is widely used as a modeling language in analysis and design stage of object-oriented software development. In UML, there are nine kinds of diagrams for describing the different sides of the system. In many cases, these diagrams have relations mutually and are not independent. Therefore, inconsistency may arise between diagrams. In development of a large-scale and complicated system like today, the possibility that such inconsistency will arise is very high. However, the CASE tool that checks the consistency between diagrams sufficiently doesn't exist now, although checking consistency by a hand is difficult.

As a main related research, there is a research on the syntactical consistency checking between diagrams[1]. However, this system limits to the consistency checking for the checking items predefinded. And users cannot

define invariants by theirself. On the other hand, there are a research on verification of the model which got even into the semantics[2]. The verification method of this research needs deep inferring with the HOL theorem proof system. So it is not suitable for general users.

2 Purpose

The aim of this reserch is the realization of syntactical consistency checking system for the diagrams described by UML(Unified Modeling Language)[3] with the following features.

- UML model consistency checking of invariants over an UML meta-model
- Users can define invariants by theirself
- practical and general-purpose system

Since the system is limited to syntactical consistency checking, computer resources is comparatively less needed.

3 Approach

In this reserch, the system which was the purpose could be devised and realized. In this system, users can define the invariants over an UML meta-model with OCL(Object Constraint Language)[4]. OCL is the standard constraint description language of UML, and it is easy to read and write invariants, although OCL is a formal Language. Also, OCL is a language that has types, and had been developed caring about the computer process.

The consistency checking system proposed by this research are given invariants first. Next, the OCL parser analyzes the syntax of OCL invariants, and generates an abstract syntax tree. At the time of abstract syntax tree generation, the type checking of OCL invariants is also executed using the UML meta-model given beforehand to the OCL parser. And the Java program for consistency checking executes consistency checking with that

abstract syntax tree and the model to be examined as inputs, and the result of checking is outputted.

Both a model to be examined and an UML meta-model required for the type checking of OCL invariants are UML XMI(XML Metadata Interchange) documents generated automatically from the model by a modeling tool. XMI[5] is a OMG standard specification and definds the structure for exchanging models using XML(eXtensible Markup Language). With XMI standard, UML XMI DTD(Document Type Declaration) which is the type of the XML document(UML XMI document) and stores an UML model, is derived from UML meta-model. Currently, some modeling tools support the automatic generation function of the UML XMI document from the model drawn, and UML XMI document are becoming the general-purpose file format which stores model informations.

In order to realize the above-mentioned system, each technique of consistency checking(the realization method of a collection, the object generation method from a UML XMI document, and so on)was established.

Then, the system implemented based on the technique of the devised consistency checking methods was tested using an exercise, and the validity of this system could been shown.

4 Implementation and Test

Based on the established technique of consistency checking, the system was implemented and tested using the exercise. As a result of the checking, all output were correct against the given OCL invariants. Therefore, it was shown that the syntactical consistency checking between diagrams could be executed correctly using the approach of this research.

5 Summary

In this research, the practical and general-purpose syntactical consistency checking system between diagrams that users can define OCL invariants

for UML meta-model was devised and realized.

In order to realize the above-mentioned system, some techniques of consistency checking(the realization method of a collection, the object generation method from a UML XMI document, and so on) were established.

Based on the established techniques of consistency checking, the system was implemented and tested using the exercise. As a result of the test, all outputs were correct against the given OCL invariants. Therefore, it was shown that syntactical consistency checking between diagrams could be executed correctly using the approach of this research.

The subjects in this research are shown below.

- Correspondence to the full set of OCL grammar
  Consistency checking is to be enabled to the OCL invariant described using the full set of OCL grammar.
- Support of the OCL invariants creation using the UML meta-model
  Generally, description of OCL invriants to be checked becomes long. Using UML meta-model, OCL invariant Creation is to be supported.
- Clarification of the OCL grammar range in which consistency checking is possible
  What invariant is to be checked correctly or not to be inspected? The grammar range is to be clarified.
- Applying to a large-scale exercise
  Using a large-scale actual exercise(ex. model of ITS(Intelligent Transport Systems)), the validity of this system is to be shown.

References

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