Refinement Equivalence in Model-Based Reuse: Overcoming Differences in Abstraction Level

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ABSTRACT

Reuse of models assists in constructing a new model on the basis of existing knowledge by retrieving a model that matches a preliminary partial input model or some facts about the domain and adapting it to the current needs. It often employs similarity measures to identify reusable models that are structurally and semantically similar to the input model. However, in many cases, an input model, being a preliminary one, is of a higher level of abstraction than the detailed models to be retrieved, and structural similarity cannot be detected. This paper proposes the concept of refinement equivalence, which means that a detailed model is a refinement of an abstract input model. Measuring refinement equivalence rather than structural similarity enables retrieving an appropriate model, despite differences in the abstraction level between the models. The paper discusses the structural characteristics of refinement operations in Object-Process Methodology (OPM) models and presents an algorithm that detects refinement equivalence.

Keywords: abstraction; model reuse; object-process methodology; similarity

INTRODUCTION

The benefits of applying reuse at various stages of design and implementation have been recognized widely. Reuse of software components has been addressed for more than 40 years, and the idea has been extended to other and more abstract design tasks and artifacts, such as design specifications (Eckstein et al., 2001; Kim, 2001; Reinharz-Berger et al., 2002; Zhang & Lyytinen, 2001), requirements engineering (Lai et al., 1999; Massonet & Lamsweerde, 1997; Sutcliffe & Maiden, 1998), conceptual models (Pernici et al., 2000), enterprise modeling (Chen-Burger et al., 2000), method engineering (Ralyte & Rolland, 2001), and others.

Reuse usually employs a repository of reusable artifacts, a retrieval mechanism that retrieves artifacts that meet criteria posed by the user, and a mechanism that enables the user to adapt the artifact and use it in the current design task. Retrieval
can be index-based, according to indices that characterize the artifacts; formal specification-based, by matching formal specifications of the artifact (e.g., signature); or model-based, by matching an input model (query) given by the user with a model stored in the repository (Mili et al., 1995). The model may be the reusable artifact or its representation. While index-based retrieval is relatively simple and quick, formal specification or model-based retrieval is more accurate, relying on a higher volume of information than in a classification represented by indices.

When the reusable artifact is a model, the purpose of reuse is to assist in constructing a new model, either of the same domain or of another domain by analogical reasoning. Two types of reusable models can be used for this purpose. One is a generic high-level domain model that has to be specialized in adaptation to the current needs. Retrieval, in this case, can be index-based, since descriptive indices are sufficient for such generic models. The other type of reusable model is a complete and detailed model that matches partial information available about the domain. Model-based retrieval, relying on all the information captured in a model, enables the selection of the model that best fits the user’s query. It may use a preliminary partial model or some facts about the modeled domain as an input query and retrieve a detailed model(s), found similar to the input model. When model-based retrieval is aimed at retrieving other artifacts represented by the model, the input model can be a detailed or a partial one.

Model-based retrieval may entail different types of similarity measures for matching between the input model and the repository models. Two common similarity measures are entity similarity and structural similarity.

Entity similarity assessment (also called semantic similarity) aims at identifying entities in the reusable models that are semantically similar to entities in the query model. It may employ mechanisms of various accuracy and complexity levels, ranging from identification of identical entity name and type (Soffer, 2002) to thesaurus-based affinity measurement (Castano et al., 1998; Ralyte & Rolland, 2001) to concept hierarchy-based distance measurement (Chen-Burger et al., 2000; Lai et al., 1999).

Structural similarity measurement typically follows the links among the entities in the query model and searches for parallels in the reusable model (Chen-Burger et al., 2000; Massonet & Lamsweerde, 1997; Ralyte & Rolland, 2001; Sutcliffe & Maiden, 1998). This is sometimes termed neighboring entities search.

In summary, a model is to be retrieved, if it includes the same entities and the same links as the input model to some extent. However, if the input model is a preliminary and partial model, and the aim of the retrieval is to obtain an appropriate complete and detailed model, then it is unlikely that the input model and the output model have the same structure and set of links. Rather, the input model would be at a higher level of abstraction, specifying an incomplete set of entities and relationships among them. The same entities would appear in the detailed model along with other entities, and, therefore, the link structure might be different, including all the other entities that exist in the detailed model.

This paper deals with the assessment of structural similarity between two models. Semantic similarity assessment has been addressed widely, both in the context of reuse (Ralyte & Rolland, 2001) and in other contexts, such as schema analysis and
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