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A CHARACTERIZATION APPROACH TO SELECTING VERIFICATION AND VALIDATION TECHNIQUES FOR SIMULATION PROJECTS

Zhongshi Wang

ITIS GmbH
Werner-Heisenberg-Weg 39
D-85577 Neubiberg, GERMANY

ABSTRACT

Conducting verification and validation (V&V) of modeling and simulation (M&S) requires systematic and structured application of different V&V techniques throughout the M&S life cycle. Whether an existing technique is appropriate to a particular V&V activity depends not only on the characteristics of the technique but also on the situation where it will be applied. This work proposes a characterization approach to identifying and specifying the information relevant for selecting V&V techniques by means of an M&S-specific characterization schema. Based on the proposed schema, an application catalog that works as an information repository for V&V techniques selection is established. This characterization is applicable to any simulation study with well defined and structured model development and V&V processes.

1 INTRODUCTION

Verification and validation (V&V) of modeling and simulation (M&S) focuses on assessing the accuracy quality characteristic of an M&S application with respect to its objectives (Balci 1998, Shannon 1975), and is intended to ensure that only correct and suitable models and simulation results are used in practice. Conducting model verification and validation requires systematic selection and application of different V&V techniques throughout the M&S life cycle. Although there are a wide variety of V&V techniques (more than 100) available, only a limited number of techniques are considered in application practice (Balci et al. 2002). The main reasons for this deficit are: 1.) theoretical information about techniques is normally distributed across different sources; and 2.) empirical knowledge about techniques application is not generally accessible (Vegas and Basili 2005). Balci (1998) presents a taxonomy of V&V techniques and illustrates which V&V techniques are generally available for each stage of the M&S life cycle. However, the way of selecting appropriate V&V techniques for a given M&S context is not sufficiently discussed.

This paper introduces an M&S-specific characterization schema including relevant attributes to specify the properties of the V&V technologies applicable to simulation projects. For the purpose of instantiation, an existing V&V technique can be characterized according to the attributes defined in the schema. Once the available techniques are characterized by this means, an application catalog supporting the V&V technique selection is build.

2 APPLICATION CATALOG FOR V&V TECHNIQUES SELECTION

The objectives of the proposed characterization schema can be outlined as follows:

- the characterization schema should provide support to select appropriate techniques for each V&V activity throughout the M&S life cycle;
- information aiding the project management with planning the V&V effort should be also included;
- the proposed characterization should be applicable to any simulation study with well defined and structured model development and V&V processes.

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When characterizing V&V techniques, two issues, i.e., the applicability of techniques and the costs of their usage, are crucial and have to be investigated. The information about technique applicability is related to the application domain of a V&V technique as regards the M&S life cycle, the ability finding model deficiencies, the operational conditions, and the way of its application. On the other hand, the issue costs includes the information related to the effort and time exposure required for understanding and mastering a technique, preparing testing data, and executing testing process. Both types of information are two sides of one coin. For example, a certain V&V technique, e.g., an objective technique, may appear more effective, but its application is typically associated with high costs because of its high complexity level. Therefore when selecting V&V techniques, these technique characteristics should be analyzed and evaluated under consideration of the specified project environment, and consequently a reasonable balance between cost and benefit should be achieved. Based on this consideration, two attribute categories: *applicability* and *cost*, are organized in the characterization schema, such as attributes like simulation type, modeling formalism, development paradigm, simulation language, system observability are defined in the applicability category and attributes like data quality required, technique objectivity required, human resource required, personnel qualification required, V&V level required are defined in the cost category.

3 V&V TECHNIQUES SELECTION STRATEGY

The proposed selection strategy is based on the comparison of the techniques characteristics instantiated in the V&V catalog with the actual project conditions, and can be well applied in connection with an existing multistage tailoring process (Wang, Lehmann, and Karagkasidis 2009). For each V&V phase, if the selection provides more than one techniques for a certain V&V phase, either one or a combination of them could be used. If, however, no suitable technique can be selected, i.e., in the current V&V catalog there exits no technique exactly matching the specified project characteristics, two attempts should be followed prior to reselection: 1.) relaxing one or more values of the project characteristics in the application profile such as requirements of data quality level or personnel qualification; or/and 2.) extending the V&V catalog with additional techniques.

4 CONCLUSION

Effective selection of appropriate V&V techniques is an essential requirement for conducting model V&V. When selecting V&V techniques, a major concern is how to identify the relevant information necessary for decision-making. This paper introduces a characterization approach to establishing a V&V techniques catalog which packages the characterized techniques together with the information about their applicability and the costs required. Our ongoing work focuses on 1.) extending the established V&V catalog with instantiating further V&V techniques; 2.) evaluating the feasibility of the characterization schema for statistical and formal techniques; 3.) (if required) adding new attributes for additional characterization aspects.

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