Using $\text{SOIQ}(D)$ to Formalize Semantics within a Semantic Decision Table

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Abstract. As an extension to decision tables, Semantic Decision Tables (SDTs) are considered as a powerful tool of modeling processes in various domains. An important motivation of consuming SDTs is to easily validate a decision table during the Validation and Verification (V&V) processes. An SDT contains a set of formal agreements called commitments. They are grounded on a domain ontology and considered as a result from group decision making processes, which involve a community of business stakeholders. A commitment contains a set of constraints, such as uniqueness and mandatory, with which we can analyze a decision table. A vital analysis issue is to detect inconsistency, which can arise within one table or across tables. In this paper, we focus on the formalization of the semantics within one SDT using the Description Logic $\text{SOIQ}(D)$. By doing so, we can use existing reasoners to detect inconsistency and thus assist decision modelers (and evaluators) to validate a decision table.

Keywords: Semantic Decision Table, Conceptual Modeling, Description Logics.

1 Introduction

An important analysis issue for decision tables is Validation and Verification (V&V [6]), the goal of which is to ensure the quality of the modeled decision rules. Validation is a process of checking whether or not the decision rules are correctly modeled according to certain meta-rules (or models). It has the requirements of building a right decision table model. Verification is a process of confirming that the decision rules are correctly built. It has the requirements of building a decision table right. V&V is a mandatory step towards ensuring the consistency and correctness of a decision table. More specifically speaking, validation is to ensure its consistency; and verification is to ensure the correctness.

A Semantic Decision Table (SDT [19]) is a decision table containing semantically rich meta-information and meta-rules. It has been studied and exploited in the EC FP7 Prolix project[2], EC ITEA DIYSE project[3] and other national projects, where it has shown its usefulness in several real-life applications, such as tuning parameters of an algorithm [18, 21] and managing data semantics for smart home [16].

1 V&V is a general problem for business models, which cover decision tables as illustrated in this paper, and other models like decision trees and Bayesian networks etc.
2 http://www.prolixproject.org/
3 http://dyse.org:8080/
An SDT allows rule modelers, knowledge engineers or evaluators to analyze a decision table using domain semantics. It contains a set of formal agreements called commitments, grounded on a domain ontology, and, specified by a community of business stakeholders (domain experts). A commitment specifies how to use a binary fact types defined in the ontology. It can be 1) instantiation of a concept or a binary fact type, 2) a constraint, 3) selecting/grouping binary fact types from one or several contexts, 4) instantiation of a value for a concept if its value range is defined in a constraint, 5) articulation, which is a mapping between a concept and the glosses defined in a glossary, dictionary and thesaurus, 6) interpretation and implementation of role pairs, and 7) alignment of concepts within/across contexts.

The process of modeling commitments is also called “commitment grounding”. During this process, the domain experts (e.g., rule editors and business people) specify hidden rules and meta-rules of this decision table in the commitments, which can be stored in Semantic Decision Rule Markup Language (SDRule-ML). SDRule-ML is based on First-Order Logic Rule Markup Language (FOL RuleML and developed as a markup language for ontology-based semantic decision support languages and models.

There are a few existing V&V approaches for decision tables. Shwayder proposes combining decision columns in a decision table in order to reduce redundancies. Pooch illustrates a survey on decomposition and conversion algorithms of translating decision tables in order to check for its redundancy, contraction and completeness. Vanthienen et al. illustrate using PROLOGA (a decision table tool) to discover the intra-tabular anomaly, which is caused by a cyclic dependence between a condition and an action, and inter-tabular anomaly, which is caused by redundancy, ambivalence and deficiency. Qian et al. use the approach of approximation reduction to managing incomplete and inconsistent decision tables. Incomplete and inconsistent decision tables are reduced into complete and consistent sub tables. Other related work can be found in.

Compared to their work, our approach is focused on using ontological axioms as the meta-rules for validating a decision table. As an ontology is shareable and community-based, the SDT validation process thus supports group activities in a nature way. Decision modelers and rule auditors share their common view through this process. By doing so, misunderstanding is minimized and the cost is consequently reduced.

Inconsistency can arise within one decision table or across tables. In this paper, we focus on the former situation. In our previous papers, we have studied how ontological constraints can be directly used within one SDT and how RDFS/OWL constraints can be mapped from/to SDRule-ML. Yet the formalization and semantics concerning computational properties for validating an SDT remain unanswered, which becomes the paper motivation and our main contribution. In addition, we need to point out that our effort here is restricted to the process of validation in V&V. Verification is out of the paper scope.

In this paper, we formalize the semantics within an SDT using the Description Logic (DL) language SOIQ(D), which has an advantage of the availability of reasoning algorithms and tools. The paper is organized as follows. Sec.2 is the paper background.