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A b s t r a c t. In recent work the notion of a secrecy logic \( \mathcal{S} \) over a given deductive system \( \mathcal{S} \) was introduced. Secrecy logics capture the essential features of structures that are used in performing secrecy-preserving reasoning in practical applications. More precisely, they model knowledge bases that consist of information, part of which is considered known to the user and part of which is to remain secret from the user. \( \mathcal{S} \)-secrecy structures serve as the models of secrecy logics. Several of the universal algebraic and model theoretic properties of the class of \( \mathcal{S} \)-secrecy structures of a given \( \mathcal{S} \)-secrecy logic have already been studied. In this paper, our goal is to show how techniques from the theory of abstract algebraic logic may be used to analyze the structure of a secrecy logic and draw conclusions about its algebraic character. In particular, the notion of a protoalgebraic \( \mathcal{S} \)-secrecy logic is introduced and several characterizing properties are provided. The relationship between protoalgebraic \( \mathcal{S} \)-secrecy logics and the protoalgebraicity of their underlying deductive systems is also investigated.
1. Introduction

In several older and recent works on the security of deductive databases and knowledge bases, secrecy-preserving reasoning is at the forefront of investigations. For instance, Sicherman, de Jonge and van de Riet [16] employ logical censors to either allow or refuse answering a query posed against a complete database with the goal of answering honestly as many queries as possible while at the same time protecting secrets. Bonatti, Kraus and Subrahmanian [9] introduce databases that consist of two parts: in the first part, one finds stored all the object information about the “outside world” whereas, in the second, a multi-modal logic is used to express assumptions about the user’s beliefs concerning the world. Modalities are also used to express and reason about secrets that the database is assumed to conceal from the users. The framework is able to cope with both complete and incomplete databases, where, in the latter, some information is assumed to be unknown. More recently, in a series of papers, Biskup [2] and Biskup and Bonatti [3, 4, 5] deal with the same problem and investigate the relationship of various responding policies under a variety of assumptions comparing the advantages and disadvantages of the techniques of lying and refusal. Again the major goal is to provide as much information as possible to a querying agent while at the same time avoiding disclosure of secret or sensitive information. Similar problems have been investigated in the context of knowledge bases that are assumed to be expressed in some description logic or other decidable fragment of first-order logic in various other works (see, e.g., [17, 1, 10, 11, 18]).

In recent work introduced by the author [19], the common features of all these approaches were abstracted with the goal of initiating an investigation into the structure of the underlying logical systems and their algebraic and model-theoretic properties. A basic assumption is that reasoning is taking place over a fixed given sentential logic or deductive system $\mathcal{S} = \langle \mathcal{L}, \vdash_\mathcal{S} \rangle$. This allows many of the techniques of universal algebra, model theory and abstract algebraic logic to be employed to study the ensuing models. Apart from the underlying logic, in the application of the framework to perform reasoning, there is always given a knowledge base $K$ containing known facts about the “world”. Moreover, part of the information contained in $K$, denoted by $B$, is considered to be known to the user, either because it constitutes background information or because the user that queries the
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