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An Expansion of the Theory of Uncertain Probabilities to Include Information Algebras

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Introduction

We have recently demonstrated how to construct information algebra of coherent sets of gambles by first considering and then generalizing the multivariate model, a particular model for representing questions. An associated information algebra of coherent lower previsions, an examination of the connection between the two information algebras constructed with an instance of set algebras, and, finally, the establishment and examination of a version of the marginal problem within this framework round out this section's further generalization of the construction. Because they are their typical structures, set algebras are particularly significant information algebras. Additionally, they represent the algebraic equivalents of conventional propositional logic. Consequently, this paper also explains how the theory of imprecise probabilities naturally incorporates propositional logic [1].

Description

Miranda and Zaffalon noted that their main results could also be obtained using the theory of information algebras while analyzing the marginal problem, which is the problem of checking the compatibility of a number of marginal assessments with a global model. This observation has been expanded upon in a few of our most recent works. We have demonstrated that information algebra properties can be used to abstract the fundamental desirability properties. To put it another way, information algebra is produced by coherent sets of wagers. Peter Williams developed the very broad theory of uncertainty known as desirability, or the theory of coherent sets of gambles, in 1975 as a further development of de Finetti's theory. Because it permits us to work with any possibility space, unrestricted domains, and imprecise probabilities, it provides, in particular, a very general setting for analyzing compatibility issues [2].

In point of fact, probabilistic models for a possibility space consisting of coherent lower and coherent upper previsions are included in coherent sets of gambles. In particular, this enables us to interpret them as pieces of information about, which is the interpretation that enables us to construct information algebras of coherent sets of bets in respectively. In point of fact, information algebras are algebraic structures made up of "pieces of information" that can be manipulated using operations like combination to group them together and extraction to get information about a particular question. In they evolve into generic mathematical structures for information management from their initial introduction as axiomatic systems to generalize Lauritzen and Spiegelhalter's local computation schemes for probabilities [3].

In we construct a coherent information algebra of gamble sets, taking into account the multivariate model, a particular model for representing questions of interest. Then we generalize it. An information algebra of coherent lower previsions, an analysis of the marginal problem at this level of generality, the construction of an information algebra of subsets of, and finally the demonstration that this latter information algebra can be embedded both in the information algebra of coherent sets of gambles and in the one of coherent lower previsions round out the discussion that began. In particular, the information algebra of subsets of that was mentioned is one type of set algebra. In set algebras, pieces of information are shown in the simplest way as sets of answers to questions of interest that can be changed using standard set operations. The results of this paper also explain how set algebras, which are algebraic versions of classical propositional logic, are formally incorporated into the theory of imprecise probabilities. We also refer to a different aspect of this problem [4].

The main ideas behind desirability and information algebras are brought to mind. Taking into consideration the information algebra definition given in our context, we offer a general method for constructing set algebras of subsets of a universal set U. This approach was already presented in the draft work, but we proceed in a more direct manner by considering a different definition of information algebra that is shown to be equivalent to the one. We recall creating a coherent set of gambles information algebra. An associated information algebra of coherent lower projections was established by us. Using the illustrated method, we demonstrate the existence of links between the two information algebras of coherent lower previsions constructed and coherent gambling sets. Last but not least, we deal with a version of the marginal problem for coherent lower previsions and gamble sets [5].

Here, we provide a brief overview of information algebras theory. For a much more comprehensive discussion of the topic, see and the draft work. Information processing fundamentals are described by information algebras, which are algebraic structures. They involve a number of computer science formalities, like relational databases, multiple formal logic systems, linear algebraic numerical problems, and so on. Algebras are based on the premise that, in much different formalism for managing information, information can be broken down into parts that refer to various topics of interest. After that, these parts can be combined or the part that pertains to specific questions can be extracted.

As a result, these aspects are captured by an algebraic structure made up of "pieces of information" that can be manipulated using essentially two fundamental operations: combination to group them together and extraction to get some of the information related to particular questions. The first concept of a generic structure for managing information can be found in, where an abstract axiomatic system is presented to generalize the local computation scheme for probabilities that was suggested in. A slightly different version of this system is developed and explicitly formulated as a generic structure for inference in after realizing that many computer science formalisms are essentially instances of this axiomatic system.

Conclusion

Questions are represented as sets of logically independent variables in and our initial work in. This means that the Cartesian product of the sets of possible values (possibility spaces) of the variables involved is used to represent the set of possible answers for each question (multivariate model). The structure of questions is further generalized by taking into account semi lattices of domains in and the draft work. We assume a definition of information algebra equivalent to the most general one presented in the draft work in our works and we generalize. However, we concentrated solely on a subset of questions that are semi lattices of partitions of a universal set U (partitive models) in order to avoid working with too abstract structures. The model for the questions that are also considered in this work is based on this.

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Conflict of Interest

None.

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