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Forthcoming Papers

M. Cristani and R. Hirsch, The complexity of constraint satisfaction problems for small relation algebras

Andréka and Maddux [Notre Dame J. Formal Logic 35 (4) 1994] classified the *small relation algebras*—those with at most 8 elements, or in other terms, at most 3 atomic relations. They showed that there are eighteen isomorphism types of small relation algebras, all representable. For each simple, small relation algebra they computed the *spectrum* of the algebra, namely the set of cardinalities of square representations of that relation algebra.

In this paper we analyze the computational complexity of the problem of deciding the satisfiability of a finite set of constraints built on any small relation algebra. We give a complete classification of the complexities of the general constraint satisfaction problem for small relation algebras. For three of the small relation algebras the constraint satisfaction problem is **NP**-complete, for the other fifteen small relation algebras the constraint satisfaction problem has cubic (or lower) complexity.

We also classify the complexity of the constraint satisfaction problem over *fixed finite representations* of any relation algebra. If the representation has size two or less then the complexity is cubic (or lower), but if the representation is square, finite and bigger than two then the complexity is **NP**-complete.

P. Wang, The limitation of Bayesianism (Research Note)

In the current discussion about the capacity of Bayesianism in reasoning under uncertainty, there is a conceptual and notational confusion between the explicit condition and the implicit condition of a probability evaluation. Consequently, the limitation of Bayesianism is often seriously underestimated. To represent the uncertainty of a belief system where revision is needed, it is not enough to assign a probability value to each belief.

H. Hirsh, N. Mishra and L. Pitt, Version spaces and the consistency problem

A version space is a collection of concepts consistent with a given set of positive and negative examples. Mitchell [Artificial Intelligence 18 (1982) 203–226] proposed representing a version space by its boundary sets: the maximally general (G) and maximally specific consistent concepts (S). For many simple concept classes, the size of G and S is known to grow exponentially in the number of positive and negative examples. This paper argues that previous work on alternative representations of version spaces has disguised the real question underlying version space reasoning. We instead show that tractable reasoning with version spaces turns out to depend on the consistency problem, i.e.,

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determining if there is any concept consistent with a set of positive and negative examples. Indeed, we show that tractable version space reasoning is possible if and only if there is an efficient algorithm for the consistency problem. Our observations give rise to new concept classes for which tractable version space reasoning is now possible, e.g., 1-decision lists, monotone depth two formulas, and halfspaces.

J.D. Park and A. Darwiche, A differential semantics for jointree algorithms (Research Note)

A new approach to inference in belief networks has been recently proposed, which is based on an algebraic representation of belief networks using multi-linear functions. According to this approach, belief network inference reduces to a simple process of evaluating and differentiating multi-linear functions. We show here that mainstream inference algorithms based on jointrees are a special case of the approach based on multi-linear functions, in a very precise sense. We use this result to prove new properties of jointree algorithms. We also discuss some practical and theoretical implications of this new finding.

J. Goldsmith, R.H. Sloan, B. Szörényi and G. Turán, Theory revision with queries: Horn, read-once, and parity formulas

A theory, in this context, is a Boolean formula; it is used to classify instances, or truth assignments. Theories can model real-world phenomena, and can do so more or less correctly. The theory revision, or concept revision, problem is to correct a given, roughly correct concept. This problem is considered here in the model of learning with equivalence and membership queries. A revision algorithm is considered efficient if the number of queries it makes is polynomial in the revision distance between the initial theory and the target theory, and polylogarithmic in the number of variables and the size of the initial theory. The revision distance is the minimal number of syntactic revision operations, such as the deletion or addition of literals, needed to obtain the target theory from the initial theory. Efficient revision algorithms are given for Horn formulas and read-once formulas, where revision operators are restricted to deletions of variables or clauses, and for parity formulas, where revision operators include both deletions and additions of variables. We also show that the query complexity of the read-once revision algorithm is near-optimal.