Advances in Computer Science and Artificial Intelligence

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1 Introduction

The National Congress on Computing (ENC) has become one of the most important conferences at national level given that provides a forum of exposition of the advances in Computer Sciences and, at the same time, a gathering space of the related community. On the ENC '03 edition the Mexican scientific community proposed seven workshops: Advances in Databases and Information Retrieval, Mobile Computing, Reconfigurable Computing and FPGA's, Logic and Agents, Learning Objects, Learning Machine and Software Engineering.

On the Logic and Agents workshop, some works related to the problem of updates in ASP logic programs were presented. In this context, it was proposed an extension of the AGM postulates based on the notions of knowledge and belief. It was proposed a new definition of *update* and it was shown an application to Answer Set Programming.

Also, it was presented a new and efficient method for simplifying a logic program while keeping the original meaning. The idea is based on a set or writing rules which is also confluent.

Concerning the applications of Answer Set Programming, they were presented applications to specific problems such as the choice of a travel schedule using a software which implements the ideas studied in updates. Besides, it was analyzed the quality of some undergraduate courses using the algorithm ID3; Also, it was presented an application of A-POL to optimization and an application of ASP to problems of GIS (Geographical Information System).

On the first edition of the workshop on Deduction and Reasoning Techniques, which was organized as a satellite event to IBERAMIA 2004, different areas of research were presented. Such areas included Logic Programming and non-monotonic Reasoning, Answer Set Programming, Knowledge and Belief Representation, Deduction Technique, Automated Reasoning, Non-classical Logics, AI in education and Intelligent Tutoring Systems.

Among the papers presented we can find a system that, given an image of the Popocatepetl volcano, retrieves similar images of the volcano from a set of stored images. The system is based on a combination of the techniques Case Based Reasoning (CBR) and Image Processing and analysis; Also,it was described a system used to analyzed learning problems of mathematics in children, as well as outline a general teaching plan. Due to the nature of this problem, genetic algorithms were used in the adaptation phase of the CBR cycle.

An outline of the foundations for the development of a chess playing algorithm was presented. This algorithm relies heavily on artificial intelligence techniques, like case based reasoning (CBR).

On the theoretical side, the representation theory of finite groups is proposed as a framework for the analysis of the Grover algorithm. In such a framework it was get a generalization of that algorithm. Also, a *branch and cut* algorithm to exactly solve the #2-SAT problem was presented; In addition, an exact linear-time algorithm with respect to the size of the input Boolean formula was presented for counting the exact number of models for formulas whose clauses have one or two literals, and each variable appears twice at the most.

On the application of the theory of Answer Set, it was investigated the applicability of the theory to the design of provable correct and elaboration tolerant conformant planners. It was described an algorithm in which the search for a conformant plan is reduced to finding an answer sets of a logic program; An extension of A-POL was presented. This extension allows the representation of problems such as *the maximum flow problem*, where it is needed a dynamic solution.

Answer Set Programming was used to solve the problem of finding alternative evacuation routes in the risk zone of the Popocatepetl volcano in Mexico. Also, it was proved that CR-Programs can be translated into Brewka's *logic programs with ordered disjunction* and this result was used to implement and solve the problem using a standard answer set engine. Besides, it was emphasized that in a planning problem some of the actions may be irrelevant for achieving the given goal; This situation was analyzed and formalized.

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Among the papers presented on the LANMR '04 workshop, we can find an implementation in Answer Set Programming of a reasoning system that models the flow of lava in volcanic eruptions which can be used in the validation of evacuation plans. Also, some theoretical results in ASP (in the context of application development) were presented as well as an application of ASP on collaborative learning. Also, a proposal to use CR-Prolog to add planning capabilities to a Geographical Information System was made.

A generalization of the notion of Answer Set for arbitrary propositional theories, called Safe Beliefs, and an algorithm using the Davis-Putnam method to compute them were presented. Also, it is explored the role of some basic notions in the study of non-monotonic reasoning, such as validity, logical consequence, context, rules and assumptions; Furthermore, it is proposed that working on non-monotonic reasoning can benefit from new notions of inference, logicality and reason.

In previous research, it has been discussed the importance of identifying the cycles that occur in a logic program under the answer set semantics, and the connections between cycles and it has been proven that answer sets of the overall program are composed of answer sets of suitable subprograms. At this workshop, it was shown that cycles and cycles and cycle graphs can be generalized to *component* and *component graphs*.

A type of reasoning is used when one conclude that some property is true by showing that it is true for "almost all" cases. Is was presented a new formalism that can formalize this type of reasoning. The formalism also explains "physical induction"(if some property is true in sufficiently many cases, then it is always true), and many other types of physical reasoning.

The Second Latin American Workshop on Non-Monotonic Reasoning (LANMR06), was held in San Luis PotosíCity, Mexico on September 18th 2006; The second edition of the workshop had been organized as a satellite event to the "Encuentro Internacional de Computacin 2006" (ENC 2006). The aim of this second workshop on LANMR is to bring together active researchers in the broad area of non-monotonic reasoning, including knowledge representation, belief revision, reasoning about actions, planning, logic programming, causality, and other related topics.

The research topics included an application of argumentation theory in order to support decision making in a real world problem (it was presented an application of argumentation theory in order to support the decision of whether an organ is viable or not for transplanting), the exhibition of a general solution to the belief frame and ramification problems -two sorts of constraints were considered: the believed state constraints relating to physical laws and the believed mental constraints relating to social laws-, a discussion of the applicability of the knowledge representation language A-Prolog for the design and implementation of a commonsense knowledge base about ideologies; It was also presented a formalization of a simple motivating story, which involves an ideological conflict between countries. The notion of ideological conflict presented is a special case of a more general notion of war of ideologies, which is an important topic for the intelligence community.

Also, it was introduced the semantics for preference logic programs (these programs are in terms of preference rules). It was used Answer Set Programming as the formalism to develop such work. In addition, it was proposed a logic programming with constraints strategy to solve a problem of scheduling with a qualitative parameter.

The workshop on Logic, Language and Computation 2006 (LoLaCOM06) was co-located with the Fifth Mexican International Conference on Artificial Intelligence (MICAI 2006), and took place 13th-14th November 2006 in the Instituto Tecnológico de Apizaco in Apizaco, Tlaxcala, México. The aim of LoLaCOM06 was to bring together active researchers within three areas of interest related to Artificial Intelligence: Logic and language, Logic and Computation, and Language and Computation.

The research topics included an attempt to develop an Answer Set Prolog program to implement a well-known strategy for natural language parsing, known as *chart parsing*, an implementation of pstable model semantics which uses the well known tools: MiniSat and Lparse, a semantics for update sequences of programs (the semantics was proposed as an application of an extension of the notion of *generalized answer sets*), and a study of an exact, deterministic algorithms for computing the number of models in Boolean formulas in Two Conjunctive Form (2-CF), denoted as #2-SAT problem.

On the theoretical part, it was presented a Hilbert-style axiomatization of a paraconsistent logic called G'_3 (it was proven a soundness and completeness theorem), and a generalization to disjunctive logic programs of the following result: given a normal program P and an atom a, we have $P \vdash_C a$ if and only if $P \vdash_C a$. Also, it was shown that with a simple translation for normal programs, we can use the pstable model semantics to get the stable models of a normal program. Besides, it was introduced the notion of *partial satisfactibility* which is an alternative way of measure the satisfaction of a formula; An interesting point is that this proposal produces similar results than other merging approaches but without using distance measures, also this approach unlike most of the model-based approaches considers the case when the belief bases are inconsistent.

2 Advances on Updates

We consider the task of updating logic programs under non-monotonic reasoning and a purely logical view. Since an intelligent agent is situated in an environment which is subject to change, it is required the agent to be adapted over time. For agents utilizing logic programming techniques for representing their knowledge, it is required the agent to be capable of updating logic programs accordingly, in order to ensure adaptability. We chose one of the approaches, viz. update answer set semantics [24, 27, 10, 2]. Resides, an underlying update semantics, which specifies how new, possibly inconsistent information, have to be incorporated into the knowledge base, an agent needs to have a certain update policy, i.e., a specification of how to react upon the arrival of an update. The issue of how to specify change requests for knowledge bases has received growing attention more recently and suitable specification languages for non-monotonic logic programs have been developed [17, 18].

The main contributions in this area can be summarized as follows:

Inspired by ideas in [1] and new results presented in [19, 26, 4, 38] by Osorio et. al., we start analyzing the basic postulates about belief revision [1], from a new point of view in answer set programming that considers the notions of "knowledge" and "belief". This new interpretation gives to answer set programming a better acceptance within agent's theory. Besides, this interpretation allowed us to reconsider the AGM postulates in the context of updates. We extensively investigate, from different views, properties of program updates and answer set semantics for program updates (in particular, for the two-program case). We first analyze them from a belief revision perspective, and evaluate various (set of) postulates for revision and iterated revision from the literature [1, 10, 2, 15].

On the other hand, we conclude that many approaches about program updates do not satisfy many of the properties defined in the literature [1, 10, 2, 15]. This is partly explained by the non-monotonicity of logic programs and the causal rejection principle embodied in the semantics, which strongly depends on the syntax of rules. Furthermore, we consider that a good update theory is based fundamentally on a set of properties.

As result of a first analysis of a proposal presented in [10], we introduced in [27], a new update operator. This proposal satisfies several properties of AGM postulates, among them, a new property called "Weak Irrelevance of Syntax". These properties give to our agents an added value with respect to other proposals that do not satisfy them. It is necessary to highlight the simplicity of our proposal, which allows our agent to be able to respond in a correct and opportune way. Besides, this behavior is very similar to human's considering Kahneman's ideas [13, 14, 33, 34]. Human doesn't always make very exhaustive reasoning, mainly in situations where they must give answers in a quick, opportune, and correct way.

Continuing our analysis on updates we present our main results about updates of logic programs: a properties-based approach (published in [24]). In this proposal we presented several properties on theory updates. We consider these properties from a non-monotonic reasoning perspective, by naturally interpreting program updates as non-monotonic consequence relations. In this proposal we consider our properties under N logic. Additionally, we have presented in [5, 36, 37, 6, 35] some examples about updates on answer set programming.

In [37] we have introduced a new proposal towards the enrichment of the update operator "$\oplus$". There, we have presented a refinement of the stable model semantics for the update operator. Also, we presented a new property that allows us to face updates where new information contains rules that define a conservative extension. So, we gave an extension of our properties proven in [24], under N logic. This approach is based on the work made by Eiter et al. [10], and inspired in a recent approach presented by Alferes et al [2]. With this work, we improve and enrich the update operator proposed by Eiter et al. [10], giving as result a new update operator.

Additionally, we have explored some other alternatives on answer set programming. We introduced a definition for updates based on the notion of minimal generalized answer sets that satisfies WIS. Furthermore, we introduce a new property named Strong Consistency. Also, we showed that our semantics satisfies Strong Consistency. We compare our approach with the well-known upd operator (due to Eiter et al.). Finally, we discuss how to compute our updated models by means of a simple transformation to ordered disjunctions.

Furthermore, we illustrate another novel mechanism for updates based on Signed formulae [3]. This mechanism is used in databases context, however, it can be adapted to theories updates.

Finally, based on a recent view of Pstable models that allows talking about knowledge and beliefs of an agent, we proposed an extension of the AGM postulates based on these notions. To this extent we introduce a new principle of Irrelevance of Syntax. We present a slight version of the updated operator as defined under Pstable models that satisfies this principle. We showed that the proposal shown in [10] for update almost satisfies this principle and we propose a slight version of his operator that indeed satisfies WIS. Our ultimate goal is to question the current interpretations of the AGM postulates and motivate a better understanding of the update operators considering the logical framework that supports Pstable models

via G3 logic. Additionally, we present an implementation of pstable model semantics. The implementation uses the well known tools: MiniSat and Lparse. Also, we have shown the utility of an automatic demonstrator implemented with these tools for applications where the logic has consistence problems.

3 ASP and Logic

The idea of using modal logic to formalize non monotonic reasoning (NMR) can be traced back to McDermott and Doyle [22]. Subsequently McDermott [21] attempted to define non monotonic logics based on the standard T, S4 and S5 logics. But he observed that, unfortunately, non monotonic S5 collapses to ordinary logic S5. Moore suggested the use of auto epistemic logic (AEL) as an alternative formalization of NMR to avoid the problems encountered with standard modal logics [23]. Moore explains that the real problem with NMR S5 is not the S5 schema, but the adoption of $\Box A \rightarrow A$. He argues that "the S5 schema merely makes explicit the consequences of adopting $\Box A \rightarrow A$ as a premise schema that are implicit in the logic's natural semantics" [23]. Gelfond also showed in [11] that the perfect models of stratified logic programs can be characterized in terms of expansions of the corresponding auto epistemic theory. His characterization is based on the interpretation of *nota* as $\neg\Box a$. In fact, Baral explains in [7] that the definition of stable models in [12] was inspired by this transformation. Having in mind McDermott and Doyle's work this idea can be interpreted as bounding introspection to objective formulae (non modal sentences). Schwartz [32] proved later the equivalence of AEL with Logic KD45, and more recently Lifschitz was able to characterize the stable semantics for disjunctive programs in terms of AEL via Gelfond's translation [7]. AEL gained a lot of interest (well deserved) and while the approach based on modal logics was almost abandoned. We suggest the reader to check [20], where the reader can find in more detail a discussion of the development of the field.

The Gelfond's original interpretation and the experience on stable models semantics show how it suffices to apply modalities to literals, instead of arbitrary complex formulae, in order to express interesting problems. With this restricted syntax, it is shown that all ground non monotonic modal logics,[16], between T and S5 are equivalent. Furthermore, it is shown that these logics are equivalent to a non monotonic logic that we construct using the well known $\mathcal{FOUR}$ bilattice. We will call this semantic is called GNM-S5,[25], as a reminder of its origin in the logic S5. Furthermore in [25] it is shown that, for normal programs, that approach is closely related to the Well-Founded-by-Cases Semantics introduced by Schlipf [31] and the WFS$^+$ proposed by Dix [8, 9]. it is proved that GNM-S5 has the properties of classicality and extended cut. While WFS$^+$ also supports classicality it fails to satisfy the extended cut principle, an important property available in other semantics such as stable models. The reason is just because WFS$^+$ was defined for normal programs that do not include literals as facts. Hence, we claim that GNM-S5 is a good candidate for defining a non monotonic semantics closer to the direction of classical logic.

In [30], Pearce treats negation from a purely logical point of view, which is often suppressed in logic programming. The reason is that a semantics is customarily defined by specifying a certain class of intended models which are merely set-theoretic entries used to interpret the vocabulary of the program (eg. minimal Herbrand models, stable models, well founded models), but what it is important is to find a logic that makes correspond this entries to models in the usual sense. For instance, in some approaches it is made clear that classical logic is been used in programming, even though perhaps only a proper subclass of the classical model is selected. In the case of well founded models it is evident that they are non classical to the extend of being three-valued, but their logic in the usual sense is not normally made explicit.

In 1999 Pearce presented a work about STABLE Models [30] providing a characterization of them in terms of a collection of logics. He proved that a formula is "entailed by a disjunctive program in the STABLE Models semantics if and only if it belongs to every intuitionistically complete and consistent extension of the program formed by adding only negated atoms". Moreover, he also showed that in place of intuitionistic logic, any proper intermediate logic can be used.

There exist different attempts to provide semantics for logic programs from a logical framework. In [29] it was introduced a particular semantic called AS-WFS which was defined over general propositional theories via completions using S4. Interestingly, AS-WFS seems to satisfy most of the principles of a well behaved semantics. The main goal of [29] was to propose S4 and completions to study the formal behavior of different semantics. Having in mind results obtained by Pearce in terms of intermediate logics it would be natural to try to extend these ideas to a larger class of logics.

The STABLE semantics is based on G_3 but in [28] it is shown that it can be fully represented in the three-valued logic of Lukasewickz, also a particular semantics called $LWFS$ is constructed applying this logic, which models extensions of WFS and the Stable semantics.

Thanks to the success of the construction of Pearce, it is worth proposing and understanding the same kind of construction but considering different logics. In this way, [25] introduces a semantic constructed using a logic X as, a weak completion with respect to logic X, it is called X-Stable. In [25] are studied semantics based on weak

completions employing different logics as G'_3 , G_3, C_ω, Lukasewikz , the paraconsistent three-valued logic Pac. Semantics as G'_3 had been presented and studied in [29, 28].

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