A Roadmap on Updates

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INTRODUCTION

Updates, is a central issue in relational databases and knowledge databases. In the last years, it has been well studied in the **non-monotonic reasoning** paradigm. Several semantics for logic program updates have been proposed (Brewka, Dix, & Knonolige 1997), (De Schreye, Hermenegildo, & Pereira, 1999) (Katsumo & Mendelzon, 1991). However, recently a set of proposals has been characterized to propose mechanisms of updates based on logic and logic programming. All these mechanisms are built on semantics based on **structural properties** (Eiter, Fink, Sabattini & Thompits, 2000) (Leite, 2002) (Banti, Alferes & Brogi, 2003) (Zacarias, 2005). Furthermore, all these semantic ones coincide in considering the AGM proposal as the standard model in the update theory, for their wealth in properties. The AGM approach, introduced in (Alchourron, Gardenfors & Makinson, 1985) is the dominating paradigm in the area, but in the context of monotonic logic. All these proposals analyze and reinterpret the AGM postulates under the **Answer Set Programming** (ASP) such as (Eiter, Fink, Sabattini & Thompits, 2000). However, the majority of the adapted AGM and update postulates are violated by update programs, as shown in (De Schreye, Hermenegildo, & Pereira, 1999).

UPDATES

Update theory deals with knowledge base represented by a propositional theory. Besides, deals with incorporating new knowledge about a dynamic world. This dynamism is due to knowledge comes from the real world, what means that knowledge evolves over time. This exchange rate mainly deals with changes in the extensional part of knowledge bases. However, the problem of updating the intensional part of a knowledge base (rules and descriptions of actions) remains basically unexplored. However, the problem of updates has attracted the researchers' attention in the last years who are dealing with such updates in the setting of logic programs. Though, some interesting proposals exist with foundation in Answer set programming (ASP), such as (Eiter, Fink, Sabattini & Thompits, 2000) (Leite, 2002) (Banti, Alferes & Brogi, 2003) (Osorio & Zacarias, 2003).

Answer set programming is a new paradigm used in the solution of the update issue. Particularly, this paradigm has taken bigger force around of update theory. A lot of theoretical work around updates under ASP has been developed by connoted researchers such as: Pereira, Alferes, Eiter, Osorio, Leite, Zacarias, and others. In the last years, a lot of theoretical work was devoted to explore the relationships between intuitionistic logic and ASP (Pearce, 1999) (Lifschitz, Pearce & Valverde, 2001). These results have recently provided a characterization of ASP by intuitionistic logic as follows: a literal is entailed by a program in the answer set semantics if and only if it belongs to every intuitionistically complete and consistent extension of the program formed by adding only negated literals (Pearce, 1999). The idea of these completions using in general intermediate logics is due to Pearce (Lifschitz, Pearce & Valverde, 2001). This logical approach provides the foundations to define the notion of non-monotonic inference of any propositional theory (using the standard connectives) in terms of a monotonic logic (namely intuitionistic logic), see (Lifschitz, Pearce & Valverde, 2001) (Pearce, 1999).

STARTING WITH AGM

We start with an analysis on the AGM postulates and then we examine them with respect to update sequences. All these proposals are based on oneself principle of ***causal rejection principle***. As is well known, if new knowledge of the world is somehow obtained, and it does not have conflicts with the previous knowledge then this new knowledge only expands knowledge. If by the contrary, new knowledge is inconsistent with the previous knowledge, and we want knowledge to be always consistent in all moment, we should solve this problem somehow. We point out that new information is incorporated into the current knowledge base subject to a ***causal rejection principle***, which enforces that, in case of conflicts between rules, more recent rules are preferred and older rules are overridden.

An **update theory** is a knowledge base represented by a logic program. Then, let P be the program representing the current knowledge base, if it is updated by another program U, then P_U is a program updated of P if only if the models of P_U are the result of updating each of the models of P according to a given semantics S; to each of these models apply the update request U to obtain a new set of models *M*; P_U is any logic program whose models are exactly *M*.

The AGM approach proposes three basic operations on a belief set K: a) *expansion* K + Φ, which is simply adding the new information $\Phi \in \mathcal{L}_B$ to K. b) *revision* K * Φ, which is sensibly revising K in the light of Φ (in particular, when K contradicts Φ); and c) *contraction* K — Φ, which is removing Φ from K.

On the other hand, AGM proposes a set of postulates, K*1 — K*8, that any **revision operator** * mapping a belief set $K \subseteq \mathcal{L}_B$ and a sentence $\Phi \in \mathcal{L}_B$ into the revised belief set K * Φ should satisfy. We assume that K is represented by an epistemic state E, then the postulates K*1 — K*8 can be reformulated as in (Eiter, Fink, Sabattini & Thompits, 2000) as follows:

(K1) E * Φ represents a belief set.
(K2) $\Phi \in Bel(E * \Phi)$.
(K3) $Bel(E * \Phi) \subseteq Bel(E + \Phi)$.
(K4) $\neg\Phi \notin Bel(E)$ implies $Bel(E + \Phi) \subseteq Bel(E * \Phi)$.
(K5) $\bot \in Bel(E * \Phi)$ only if Φ is unsatisfiable.
(K6) $\Phi_1 \equiv \Phi_2$ implies $Bel(E * \Phi_1) = Bel(E * \Phi_2)$.
(K7) $Bel(E * (\Phi \wedge \gamma)) \subseteq Bel((E * \Phi) + \gamma)$.
(K8) $\neg\gamma \notin Bel(E * \Phi)$ implies $Bel((E * \Phi) + \gamma) \subseteq Bel(E * (\Phi \wedge \gamma))$.

Katsuno and Mendelzon (1991) proponed a set of postulates where a change Φ to a belief base B are propositional sentences over a finitary language. Some of the outstanding differences between the postulates of the AGM and those of Katsuno and Mendelzon are that revision should yield the same result as expansion E + Φ, providing Φ is compatible with E, which is not desirable for update in general. The postulate 8 says that if E can be decomposed into a disjunction of states (e.g., models), then each case can be updated separately and the overall result is formed by taking the disjunction of the emerging states.

Darwiche and Pearl (1997) have proposed postulates for iterated revision. This set of postulates is very simple and the majority of the adapted AGM and update postulates are violated by update programs. Another set of postulates for iterated revision, corresponding to a sequence E of observations, has been formulated by Lehmann (1995). Notice that in general the postulates proposed for iterated revision fail, and, with the exception of some postulates, each **change** is given by a single rule. Though, is that the two views described above amount to the same at a technical level.

All these approaches on the update issue consider it as a process of belief revision. However, following Gardenfors and Makinson (1991; 1994), **belief revision** can be related to non-monotonic reasoning by interpreting it as an abstract consequence relation on sentences, where the epistemic state is fixed. In the same way as Eiter we can interpret update programs as abstract consequence relation on logic programs. In spite of this, we should consider these proposals since for example Makinson (1993) considered a set of (desirable) **properties** for non-monotonic reasoning, and analyzed the behavior of some reasoning formalisms with respect to these properties.

Continuing with our research, immediately we comment in a general way the proposal of Alferes et. al., (2000). They introduced the concept of dynamic logic programs as a generalization of both the idea of updating interpretations through revision programs and of updating programs as defined by Alferes and Pereira (1997) and by Leite and Pereira (1997). Syntactically, dynamic logic programs are based on generalized logic

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