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Preface

This proceedings volume contains the revised and extended papers presented at the

First International Workshop on Nonmonotonic and Inductive Inference

that took place at the University of Karlsruhe, December 4–7 1990. This workshop was made possible by the financial support of Volkswagen Stiftung, Hannover. The application for funding was made within a special program of the Volkswagen Stiftung to promote cooperation between the Federal Republic of Germany and what was then the German Democratic Republic. The dramatic course of history also changed this program and the workshop actually provided one of the first opportunities for researchers in the field from both parts of the united Germany to come together.

Besides the major funding by the Volkswagen Stiftung we also acknowledge support from IBM Deutschland GmbH and the Campus Engineering Center of DEC at Karlsruhe.

We have grouped the contributions to this proceedings volume around some central areas of research. The first group, Nonmonotonicity and Logic Programming, refers to a field where the phenomenon of nonmonotonicity manifests itself in the very concrete form of "negation as failure". This is still one of the main motivating examples for nonmonotonic logic and a source of new developments. This area has been affected, as nonmonotonic logic in general, by a new stage in the evolution of the subject. The invention and study of singular systems of nonmonotonic reasoning has been suspended for a while to step back and

- have a broader look at what has been achieved so far,
- think about what is possible in general and what overall limitations there are,
- propose new directions.

One of the results of this process was the discovery that it is not desirable to throw out mononicity altogether, but rather replace it by the restricted requirement of cumulativity. The first paper of this volume by G. Brewka, D. Makinson and K. Schlechta starts from the observation that Justification based Truth Maintenance Systems do not possess the cumulativity property and proposes a modified version of JTM systems that do. The same topic is persued in the contribution by J. Dix. He classifies most of the known semantics for logic programs with negation according to whether they satisfy cumulativity and/or rationality or not.

The occurrence of nonmonotonicity in default or even everyday reasoning has often been explained by the fact that in this type of reasoning one does not consider validity in all models, as in classical logic, but only validity in intended models, where the notion of intended models, such as minimal models, stable models or others, varies among the different proposed theories. In the third paper in this group H. Herre proposes a general framework formalizing this approach to nonmonotonic logic and gives examples of what can be proved at this level of generality.

Probably the most successful axiomatic approach to nonmonotonic logic up to now is the study of abstract consequence relations by Kraus, Lehmann and Magidor in the tradition of A. Tarski and D. Scott. The simplest system they consider, called system

C for cumulativity, differs from Tarski's axiomatization in that monotony is no longer derivable and the axiom of cumulativity is added. To start with, consequence relations $\mid\sim$ between finite sets of formulas and a single formula were considered. Because of nonmonotonicity there is more than one way to extend $\mid\sim$ to a relation between arbitrary sets of formulas and a single formula and likewise there is more than one notion of compactness. The best-behaved notion is what is called supracompactness. These problems are addressed in the first paper, by M. Freund, of the group Axiomatic Approach to Nonmonotonic Reasoning. He describes and studies a transformation that associates with every cumulative consequence relation $\mid\sim_1$ a supracompact, cumulative consequence relation $\mid\sim_2$, that coincides with $\mid\sim_1$ on finite sets.

With all the systems of nonmonotonic reasoning studied in the past there has been associated in one way or other a notion of a proof. What has been and still is lacking is a proof theory, where such properties of proofs are considered as normal forms and the subformula property. G. Jäger analyses under a unifying perspective some notions of nonmonotonic proofs and outlines ideas that may lead to the development of a genuine proof theory for nonmonotonic logic.

The paper by V. Marek, G. Shvarts and M. Truszczyński starts from the observation that many of the proposed systems for nonmonotonic reasoning proceed in two steps. In a first step, which the authors call preprocessing, the given set of formulas is transformed and in a second step some kind of deductive closure is performed on the transformed set to yield what is called an *expansion*, one possible set of beliefs. In the simplest case, admittedly not very useful, preprocessing might be to add $\neg\phi$ for all formulas ϕ, that are not derivable from the original set, or to replace implication by equivalence, as is done in Clark's completion of logic programs. The authors analyse systematically the notion of expansion when the preprocessing and the logic used to perform the deductive closure are varied. In particular it is shown that different preprocessing schemes, like the one by McDermott and the alternative by Moore, can be made to coincide by using an appropriate modal logic. Also for the same preprocessing scheme, within certain ranges, the resulting expansions are independent of the chosen modal logic.

The paper by H. Thiele introduces a new algebraic approach to the study of abstract nonmonotonic consequence relations culminating in the proof of a representation theorem. It is still too early to tell whether the specific consequence operation of codiagonalization will be acceptable for a majority of nonmonotonic logicians, but it is beyond doubt that the model of algebraic investigation presented by Thiele in this paper will spawn future research.

In one way or another all versions of nonmonotonic reasoning incorporate the idea that one conclusion is preferable to another. This can be done by a specific choice of the intended models, by a preferential ordering on the set of worlds or states, or even more implicitly. E. Weydert proposes a different approach, where the preferential ordering is made explicit: it is represented by a relation symbol in the language and its meaning is captured by corresponding axioms. The default conditional, "usually P implies Q", $P \Rightarrow Q$, is then defined by $(P \wedge \neg Q) < (P \wedge Q)$.

The third group of papers, Inductive Inference, starts with a contribution by K.-P. Jantke, which genuinely adresses both topics of the workshop. He introduces notions of monotonic and weakly monotonic inductive inference as variations of the identification of a recursive function or a language (= set of words) in the limit, with the restriction that the approximating functions or languages identified at the finite stages in the process

increase monotonically in a sense made precise in the paper. The main result states that every class of pattern languages, that can be learnt in the limit, can also be learnt monotonically in the limit, *provided* that the inclusion problem for pattern languages is decidable (which is a famous open problem in this area).

S. Lange extends in his paper a previous result that he obtained together with R. Wiehagen, that k-variable pattern languages for fixed k can be identified in the limit by a polynomial time algorithm, to the case the polynomial time algorithm may also be required to be consistent.

In R. Wiehagen's paper the *principle of identification by enumeration* for classes of recursive functions that can be learnt in the limit is reviewed and it is shown how this principle can also be adapted to cover the case of monotonic inductive inference proposed in K.P. Jantke's contribution in this volume.

The content of the last paper in this group by T. Zeugmann is made sufficently clear by its title and nothing sensible can be added at this level of generalitiy.

One of the systems for nonmonotonic reasoning that was among the first to be proposed and studied in greater detail is autoepistemic logic, a system with a modal-logic flavour proposed by R. Moore. A point of criticism that has sometimes been raised against autoepistemic logic is that it requires an agent to believe in all logical consequences of his beliefs. J. Kalinski considers new versions of extensions in autoepistemic logic that do not assume this kind of complete belief reflection.

In the last paper of this volume, M. Morreau and H. Rott reconsider a result proved by P. Gärdenfors, that fully monotonic, expansive, successful and consistency-preserving update functions are trivial. They motivate the introduction of a different kind of update function, in a context that the authors prefer to call *adaption* rather than *update*. For this new update function other properties also become relevant. But again the authors can prove a trivialization result: Any update function respecting independence, which is successful, efficient and weakly monotonic and which preserves consistency is trivial.

Karlsruhe, July 1991 P. H. Schmitt

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