Abstracts of Current Literature

Semantically Guided Hierarchical Deduction and Equality Conditional Resolution
DAI V47(12), SecB, pp4965
Wang, Tie-Cheng
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This dissertation is concerned with research in designing computer programs which are effective in finding, or helping to find, proofs of theorems of first order logic. Discussed herein are three interrelated topics. The first topic is the design of a new, goal-oriented proof procedure—hierarchical deduction. The second topic is semantically guided hierarchical deduction, which concerns issues related to designing models for guiding the search of a particular version of this procedure. The third topic is equality conditional resolution, which provides a control strategy useful for further development of hierarchical deduction.

The hierarchical deduction procedure (HD) proves a theorem by searching for a proof acceptable to a hierarchical deduction structure; those derivations which are irrelevant to this proof are limited by means of a set of completeness-preserving refinements. In addition to the basic algorithm, there is a partial set of support strategy which provides a simple but effective way to incorporate semantics and human factors.

Semantically guided hierarchical deduction (SHD) is defined from HD for incorporating domain-dependent knowledge presented in models. A set of rules by which a user designs models for SHD is investigated and applied to design models for helping a SHD-prover prove efficiently a series of non-trivial theorems. In order to include type information and other human factors into models, a three-value interpretation is introduced.

An ECR strategy is described through studying an equality conditional resolution proof procedure (ECR). ECR incorporates a user's knowledge concerning the different roles of input equations and other hypotheses in a proof. The input equations are transformed into different classes of rules according to the roles they will play. The conditions on the application of these rules control their inference and prevent inappropriate use of them. An ECR-prover, which is a modified SHD-prover enhanced by the ECR strategy, is implemented and proves efficiently a number of theorems from mathematics.

For each of these topics, a summary of results obtained by the computer implementations is presented, and a concluding remark is made in comparison with the performance of others. Issues related to the extension and further development of SHD and ECR proof procedures are discussed in the final chapter. The proofs concerning the completeness of the basic algorithm of the hierarchical deduction are included in an appendix.

Updating Databases With Incomplete Information
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Winslett, Marianne Southall
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Suppose one wishes to construct, use, and maintain a database of facts about the real world, even though the state of that world is only partially known. In the AI domain, this problem arises when an agent has a base set of beliefs that reflect partial knowledge about the world, and then tries to incorporate new, possibly contradictory knowledge into this set of beliefs. In the database domain, one facet of this situation is the well-known null values problem. We choose to represent such a database as a logical theory, and view the models of the theory as representing possible states of the world that are consistent with all known information.

How can new information be incorporated into the database? For example, given the new information that "b or c is true," how can one get rid of all outdated information about b and c, add the new information, and yet in the process not disturb

any other information in the database? In current-day database management systems, the burden of determining exactly what to add and remove from the database is placed on the user.

Our research has produced a formal method of specifying the desired change intentionally, by stating a well-formed formula that the state of the world is now known to satisfy. The database update algorithms we provide will automatically accomplish that change. Our approach embeds the incomplete database and the incoming information in the language of mathematical logic, and gives formal definitions of the semantics of our update operators, along with proofs of correctness for their associated algorithms. We assess the computational complexity of the algorithms, and propose a means of lazy evaluation to avoid undesirable expense during execution of updates. We also examine means of enforcing integrity constraints as the database is updated.

This thesis also examines the question of choices of semantics for update operators for databases with incomplete information, and proposes a framework for evaluation of competing candidate semantics. Several candidate semantics are evaluated with respect to that framework.

An experimental implementation of our method has been constructed, and we include the results of test runs on a range of patterns of queries and updates.

An Experimental Comparison of Uncertain Inference Systems
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Wise, Ben Paul
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Uncertainty is a pervasive feature of the domains in which expert systems are supposed to function. There are several mechanisms for handling uncertainty, of which the oldest and most widely used is probability theory. It is the only one which is derived from a formal description of rational behavior. For use in patten-directed inference systems, or rule-based inference engines, artificial intelligence researchers have favored others largely for reasons of simplicity and speed. We have developed techniques which measure how these alternatives approximate the results of probability theory, assess how well they perform by those measures, and find out what underlying features of a problem affect performance.

Because the amount of data required to fully specify a probability distribution is enormous, some technique must be used to estimate a distribution when only partial information is given. We give intuitive and axiomatic arguments, algebraic analysis, and numerical examples, that fitting maximum entropy priors and using minimum cross entropy updating are the most appropriate ways to do so.

For several uncertain inference systems, detailed analysis of operations have been performed to elucidate which basic problem-features bias the answers and what are the directions of the biases. We present and discuss both the motivation and design of our analysis techniques, and the specific structures which were found to have strong effects on perf ormance. The techniques have also been tried on several variations of a fragment from a real expert system, with qualitatively similar results.

We have found that the newer uncertain inference systems often re-incorporated features of general probability theory which have been eliminated in earlier systems. Moreover, we found that newer systems sometimes continued exactly the features which they were supposed to eliminate, albeit in

different notation. For every simple uncertain inference system, we found not only structures for which the performance was very good, but also structures for which performance was worse than random guessing, systematic bias was present, or data was interpreted as having the opposite of its true import.

Assessing and Forecasting the Implications of Artificial Intelligence Systems on Pedagogy in The Public Sector
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Skolyan, Kenneth Stephen
United States International University
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The Problem. The purpose of this study was to assess and forecast the implications artificial intelligence systems would have on teaching methods, teacher training, curriculum and teacher-student roles in public education.

Method. A three-round Delphi Study was conducted. The Delphi Panel included 23 participants from the areas of A. I. research, computer-using teachers from universities and high schools, and writers in the field.

Results. (I) Teacher Training and Reaction. (1) Resistance to the introduction of artificial intelligence systems will occur. (2) Additional training for teachers in computers is likely. (3) The structure of teacher training will change from informational transmittal to learning how people learn and the structure of what they know. (II) Curriculum. (1) Schools will not be radically changed. The goals of education and the importance of reading and writing would remain. (2) Students would not be learning a large portion of their lessons at home. (3) Elitist separation by subject matter or social adjustment would not occur. (4) The classroom would change. Multi-leveled, multi-topical learning centers would be developed where students could learn at their own pace. Changes in testing would occur along with deeper student involvement with subject matter. (5) New subjects and increases in strategy development and problem solving would occur as a result of A. I. systems in the classroom. (6) The A. I. system would become an indispensable tool with frequent upgrade of use skills and development of new subjects occurring. (III) Teacher/Student Roles. (1) Teacher roles would not change from deliverance of knowledge and skills to parent, counselor, or psychologist. (2) A. I. systems would not fill the role of parent, counselor, or psychologist nor transmit values. (3) The role of teacher would change from learning director to co-problem solver. (4) A. I. systems would greatly assist teachers in improving learning experiences, diagnosing problems, and assisting students with learning handicaps.

A Speech Act Theory of Metadiscourse
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Beauvais, Paul Jude
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Metadiscourse commonly is defined as "discourse about discoursing". In its brief history, the term has appeared in several models of text structure; however, theorists disagree concerning the range of metadiscursive structures and the role of metadiscourse in a larger theory of text linguistics. This dissertation provides a detailed history and a critical analysis of the existing metadiscourse theories, and it offers an alternative theory that defines metadiscourse as a component of speech act theory.

The first chapter surveys the history of metadiscourse from Zellig S. Harris' early use of the term to recent studies by Joseph M. Williams, Avon Crismore, and William J. Vande Kopple.

The second chapter introduces four criteria for evaluating the utility of theoretical models. The existing metadiscourse models are analyzed in light of these criteria and are found to contain

imprecise definitions of key terms. The models also are found to be collections of disparate structures instead of principled systems.

The third chapter provides an overview of important works on speech act theory by J. L. Austin and John R. Searle. Particular attention is devoted to the distinction between illocutionary acts and propositions, the differences between explicit performative structures and implicit expressions of illocutionary intent, and the types of illocutionary acts that are possible.

In the fourth chapter, metadiscourse is defined as those illocutionary force indicators that identify expositive illocutionary acts. A taxonomy of metadiscourse types is provided, and canonical forms using performative or near-performative structures are identified for each type. Partially explicit forms of metadiscourse that do not provide an attributive subject are also identified.

The dissertation concludes with suggestions for experimental studies using the proposed metadiscourse model.

Towards Computational Discrimination of English Word Senses
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Finn, Kathleen Ellen
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Although acoustically based automatic speech recognition (ASR) systems have witnessed enormous improvements over the past ten years, they still experience difficulties in several areas, including operation in noisy environments.

Research with human subjects has shown that visible information about the talker provides extensive benefit to speech recognition in difficult listening situations. The primary purpose of this study was to demonstrate the feasibility of performing automatic speech recognition based only on optical information. Other purposes included characterizing the nature of the optical recognition process, comparing it to human visual speech perception, and estimating its potential value to acoustic-based ASR.

An optically-based algorithm was developed to recognize a set of 23 English consonant phonemes. Distance measurements were derived from a set of 12 dots placed on or near the speaker's mouth. The dots offered a computationally simple means of tracking lip movements.

After data reduction and selective weighting of the variables, five distance variables were found capable of identifying 74% of the phonemes, with no acoustic information whatsoever. The same variables correctly identified 87% of the phonemes by viseme groups. The machine's viseme set was very similar to the human set.

The preponderance of the variables measured vertical distances, suggesting that vertical opening, as opposed to horizontal movement or area of mouth opening, is a critical cue to optical speech recognition. The optical recognition process was subjected to the effects of random visual noise at various levels, and was found to be fairly robust.

The results of the optical recognition algorithm were compared against the results of an acoustic algorithm operating over the same speech tokens. The acoustic algorithm's performance, subjected to signal-to-noise ratios ranging from +25 dB to +65 dB, measured 64% correct phoneme recognition. It was estimated that an effective combination of the optical and acoustic recognition systems could result in 95% recognition.