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Abstracts of Recent PhDs

Modeling Arguments and Uncertain Information: A Non-Monotonic Reasoning Approach

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Abstract

In the context of knowledge representation, by considering ideas from possibilistic logic and answer set programming approach, we define a possibilistic disjunctive logic programming approach for modelling uncertain, incomplete and inconsistent information. This approach introduces the use of possibilistic disjunctive clauses, which are able to capture incomplete information and incomplete states of a knowledge base at the same time. This approach is computable and moreover allows encoding uncertain information by using either numerical values or relative likelihoods. In order to define the semantics of the possibilistic disjunctive programs, three approaches are defined:

- First is strictly close to the proof theory of possibilistic logic and answer set models;
- second is based on partial evaluation, a fix-point operator and answer set models; and
- third is based on the proof theory of possibilistic logic and on pstable semantics.

In order to manage inconsistent possibilistic logic programs, a preference criterion between inconsistent possibilistic models is defined; in addition, the approach of cuts for restoring consistency of an inconsistent possibilistic knowledge base is adopted.

Argumentation theory is also explored in this work. We present novel results in the exploration of the relationship between extension-based argumentation semantics and logic programming semantics with negation as failure. On the basis of a suitable mapping of an argumentation framework into a normal logic program, we define a direct relationship between argumentation semantics (e.g. the preferred semantics) and logic programming with answer set models (which is one of the most successful approaches of non-monotonic reasoning of the past two decades). As a consequence of this result, we are able to suggest an easy-to-use method for implementing argumentation systems under the platform of answer set solvers. In addition, we show that the preferred semantics can be characterized by the logic programming semantics—pstable semantics. This result suggests that one can explore the non-monotonic properties of the preferred semantics by considering paraconsistent logics.

An interesting point of exploring argumentation semantics, from the point of view of logic programming semantics, is that one can deal with some of the inconveniences of the argumentation semantics, for example, emptiness and non-existence. Hence, by considering the idea that argumentation semantics can be viewed as a special form of logic programming semantics with negation as failure, we show that any logic programming semantics as the answer set semantics, the minimal models, the pstable semantics, etc. can induce new candidate argumentation semantics. These candidate argumentation semantics will overcome some of the problems of the Dung's argumentation approach that have been discussed in the literature. The new argumentation semantics are based on a new recursive framework for logic programming semantics. This framework generalizes any logic programming semantics in order to build logic programming semantics, which are always defined, satisfy the property of relevance and agree with the answer set semantics for the class of stratified logic programs.

New Reordering and Modeling Approaches for Statistical Machine Translation

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Abstract

This thesis focuses on the statistical machine translation (SMT) framework and primarily on the definition and experimentation of novel algorithms for building a correct structural reordering for translated words. Moreover, challenging techniques regarding language modeling and system combination

are successfully applied to state-of-the-art SMT systems.

To begin, a thorough study of the SMT state-of-the-art is performed. Ngram- and phrase-based SMT feature functions are described. The former, which has been developed in our research group, is used as a baseline system and the latter, given its popularity, is used to deepen the new techniques during experimentation. Then, the introduction of continuous space language models is reported and analyzed in an Ngram-based system that uses translation and target language models. The continuous space language modeling technique is based on projecting word indices onto a continuous space. The resulting probability functions are smooth functions of the word representation. Events are better estimated than in standard smoothing methods, which are shown by the significant reduction in perplexity. This better probability estimation allows for an improvement in translation quality. Moreover, this thesis performs a two-system combination considering the phrase- and Ngram-based systems. Multiple outputs of both systems with their corresponding score are concatenated, and for each system translation the score given by the opposite system is computed. The final translation is properly chosen by simultaneously considering the scores given by both systems.

Finally, this thesis proposes the introduction of novel statistical reordering techniques in an SMT system. The first approach is based on an algorithm that detects, learns and infers pairs of words in the source language that swap in the target language providing accurate local reorderings. The second approach consists of generating weighted reordering hypotheses using the same powerful techniques of SMT systems in order to undo the source language structure and to make it more similar to the target language structure. Therefore, the translation challenge is divided into two steps: predicting the order of the words in the target language and substituting these words in the target language. In order to infer new reorderings that were not learnt during training, the SMR system uses word classes instead of words themselves. In order to correctly integrate the SMR and SMT systems, both are concatenated, by using a word graph. This approach is an elegant and efficient reordering approach that is capable of achieving significantly improved translation in the target language.

A Theory of Complex Adaptive Inquiring Organizations: Applications to Continuous Assurance of Corporate Financial Information

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Abstract

Drawing upon the theories of complexity and complex adaptive systems and the Singerian Inquiring System from C. West Churchman's seminal work *The Design of Inquiring Systems* the dissertation herein develops a system design theory for continuous auditing systems. The dissertation consists of discussion of the two foundational theories, development of the Theory of Complex Adaptive Inquiring Organizations (CAIO) and associated design principles for a continuous auditing system supporting a CAIO, and instantiation of the CAIO theory. The instantiation consists of an agent-based model depicting the marketplace for Frontier Airlines that generates an anticipated market share used as an integral component in a mock auditor going concern opinion for the airline. As a whole, the dissertation addresses the lack of an underlying system design theory and comprehensive view needed to build upon and advance the continuous assurance movement and addresses the question of how continuous auditing systems should be designed to produce knowledge—knowledge that benefits auditors, clients, and society as a whole.

A Framework for Automated Process-Product Analysis of Collaboration in Groupware Systems

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Abstract

Recent years have seen a proliferation of technological systems designed to allow for collaboration and communication between groups of people (electronic messaging systems, social networks, shared workspaces, etc.). Within this context, there emerges the challenge of analyzing the work processes supported by the collaborative systems in order to improve the experience of the participants and to adapt the support offered by these systems to the specific needs of each case. Analyzing collaboration and interaction within the processes of group work is a complex task that requires many issues to be resolved, such as what information is to be processed, how variables for analyzing the group work and the resulting products are to be inferred, and how the results of the analysis can be used to improve the users' activity. To facilitate these tasks, the work that we present here focuses on modeling and automating the collaboration and interaction analysis in order to better understand how user groups orchestrate their activity and to evaluate the products that result from the work that they carry out.

The research hypothesis of this thesis proposes that it is feasible to design and build a framework that provides software developers with a guide and an effective support for the construction of systems that automate the analysis—whether separate or combined—of the

collaborative process and, in the form of artefacts or products, the results of this process. In order to validate this research hypothesis, the main objective of this project is to build just such a framework, made up of a conceptual framework and a technological framework, so as to facilitate the automation of the collaboration and interaction analysis tasks. The conceptual framework consists of a set of ontologies that define and explicitly relate all of the elements involved in the collaboration and interaction analysis. The technological framework includes a computational support that enables developers to follow a model-driven approach to carry out the analysis processes automatically. This computational support is functionally structured into three levels: (i) the meta-information level, where the analysis processes are modelled using visual tools and the work processes to be studied are specified; (ii) the analysis level, where the models specified in the previous level are processed, combined and transformed to create a computational support that allows for the automatic execution of the analysis processes; and (iii) the collaboration level, where interaction with the collaborative system occurs in order to capture the actions and products generated in the course of the collaborative activity, to calculate variables for analyzing the collaborative process and, ultimately, to improve the users' work according to the results of the analysis.

In order to evaluate and validate the proposed framework, several theoretical and practical studies with real users have been carried out to analyze collaboration and interaction within different work scenarios, which differ in terms of the type of collaborative system used and the nature of the tasks performed by the participants. Likewise, we have empirically studied how some automated analysis processes lead to an improvement in users' activity. The results of these studies have made it possible to validate the formulated research hypothesis since the proposed framework has enabled the automation of the required analysis tasks and the various participants have provided a positive evaluation of the support provided by the framework.