Chapter 12

Conclusions

12.1 Summary

A new framework and novel algorithms of hierarchically sorted Inductive Logic Programming have been described, and extended ILP has been successfully applied to the information extraction task. Three kinds of approaches to extending ILP were presented. RHB learns logic programs based on τ-terms from positive and negative examples. RHB$^+$ learns logic programs based on τ-terms from only positives. ψ-RHB$^+$ learns logic programs based on ψ-terms from only positives. Applying the extended ILP to information extraction showed high overall performance. ψ-RHB$^+$ can learn hypotheses with more representation power than RHB$^+$; however, ψ-RHB$^+$ requires several times more learning time than RHB$^+$. This indicates that the learning method should be carefully chosen according to the presentation styles of articles in a domain. Finally, this thesis showed a new framework of inductive logic programming and demonstrated a successful application field for the new framework.

12.2 Future Work

For hierarchically sorted ILP, enhancing learning speed is an important future work, especially for applying a large number of examples from real-world problems. Implementing a learner in C would markedly im-

prove the learning speed and memory size. However, since this implies the need for a new implementation of a theorem prover for logic programs based on ψ-terms or τ-terms, this work will require long-term development. Theoretically, there is room for studies on formalization of generalization based on OSF-formalism and Plotkin's work on generalization.

Using natural language sentences as background knowledge (NLBK), which is shown in Part II, might be a highly promising direction. Describing background knowledge in logic programs is not such an easy task for end users, so NLBK will expand applicable cases of ILP to practical domains. This direction will not only enable users to write background knowledge in natural language but also provide an opportunity to use existing natural language texts as background knowledge. Although case studies of NLBK in IE is shown in this thesis, there will be many more fields that can utilize the benefits of NLBK.

In IE, semantic representations of texts should be used more commonly to achieve deep understanding of the contents of the texts. As shown in this thesis, semantic-level information extraction rules exhibit good performance in IE. Apart from ILP, learning information extraction rules themselves are of interest. Currently, most approaches to IE pattern learning employ supervised learning and thus need examples. Unsupervised learning of IE rules will become an attractive research area in the near future.