Introduction to the Applications of Domain Ontology

Chang-Shing Lee
Department of Computer Science and Information Engineering
National University of Tainan, Taiwan
E-mail: leecs@mail.nutn.edu.tw / leecs@cad.csie.ncku.edu.tw

1. Preface

Recently, the research on the ontology has been spread widely to be critical components in the knowledge management, Semantic Web, business-to-business applications, and several other application areas. In this article, I would like to introduce some applications of domain ontology presented by my research team in Taiwan, including "*an ontology-based fuzzy image filter and its application to image processing*," "*a fuzzy ontology and its application to news summarization*," "*a genetic fuzzy agent using ontology model for meeting scheduling system*," and "*an ontology-based intelligent healthcare agent and its application to respiratory waveform recognition*."

2. Ontology-based Fuzzy Image Filter and Its Application to Image Processing

Nowadays, the techniques of image processing have been well developed, but there are still some bottlenecks that have not been solved. For example, many image processing algorithms cannot work well in a noisy environment; therefore, the image filter is adopted as a preprocessing module. The process of image transmission could be corrupted by impulse noise, which causes the corrupted image to be different from the original one. We propose an ontology-based fuzzy image filter to remove additive impulse noise from highly corrupted images. The proposed filter consists of a *fuzzy number construction process*, a *fuzzy filtering process*, a *genetic learning process*, and a *noisy ontology*. First, the *fuzzy number construction process* will receive sample images or the noise-free images, then construct a *noisy ontology* for the *fuzzy filtering process*. Second, the *fuzzy filtering process* contains a *parallel fuzzy inference mechanism*, a *fuzzy mean process* and a *fuzzy decision process* to perform the task of noise removal. Finally, based on the genetic algorithm, the *genetic learning process* will adjust the fuzzy numbers of the *noisy ontology*. The experimental results show that the ontology-based fuzzy image filter can remove the impulse noise effectively and efficiently.

3. A Fuzzy Ontology and Its Application to News Summarization

In this section, we introduce a fuzzy ontology and its application to news summarization. The fuzzy ontology with fuzzy concepts is an extension of the domain ontology with crisp concepts. It is more suitable to describe the domain knowledge than domain ontology for solving the uncertainty reasoning problems. In addition, a news agent based on the fuzzy ontology is also developed for news summarization. Fig. 1 shows the process of the fuzzy ontology construction. The news domain ontology with various events is predefined by domain experts. The document preprocessing mechanism will generate the meaningful terms based on the news corpus produced by the retrieval agent and the Chinese news dictionary defined by domain experts. Then the term classifier will classify the meaningful terms according to the events of the news. The *fuzzy inference mechanism* will generate the membership degrees for each fuzzy concept of the fuzzy ontology. Every fuzzy concept has a set of membership degrees associated with various events of the domain ontology. In addition, a news agent based on the fuzzy ontology is also developed for news summarization. The news agent contains five modules, including a *retrieval agent*, a *document preprocessing mechanism*, a *sentence path extractor*, a *sentence generator*, and a *sentence filter* to perform news summarization. The experimental results exhibit that the fuzzy ontology can assist the news agent in summarizing the Chinese news effectively.

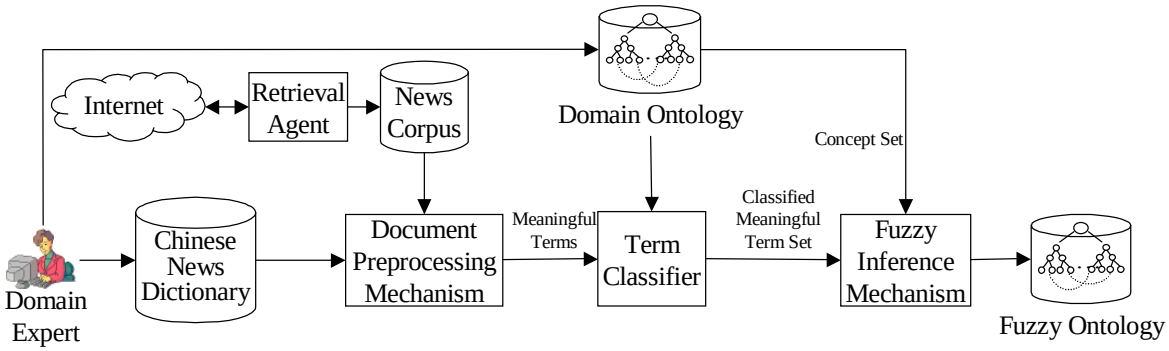

Fig. 1. The process of the fuzzy ontology construction [1].

4. **A Genetic Fuzzy Agent Using Ontology Model for Meeting Scheduling System**

In this section, we describe the ontology model for the *Meeting Scheduling System* (*MSS*). Fig. 2 shows the architecture of ontology-based fuzzy inference mechanism of *Genetic Fuzzy Agent* (*GFA*). It is a three-layered network, which can be constructed by directly mapping from a set of specific fuzzy rules, or can be learned incrementally from a set of training patterns.

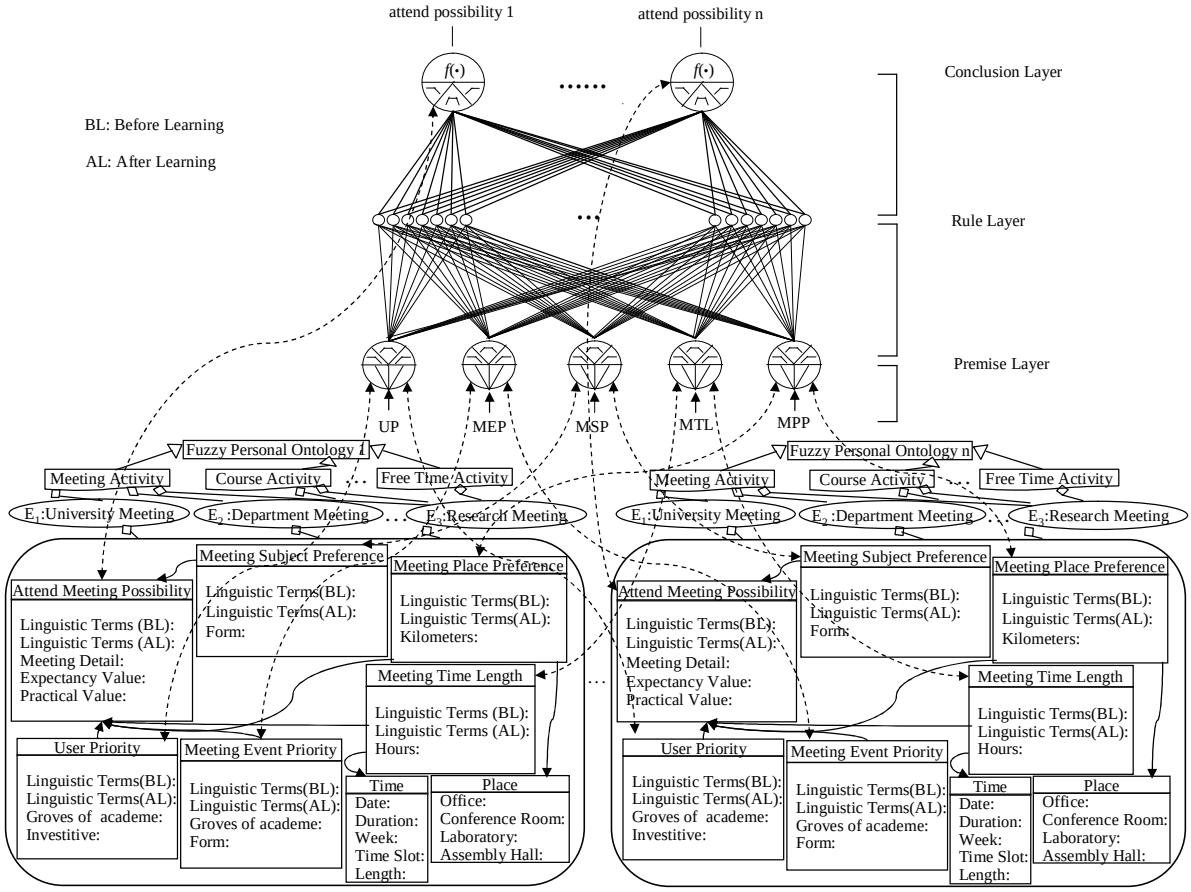

Fig. 2. The architecture of ontology-based fuzzy inference mechanism of *GFA* [3].

The *GFA* can support a meeting host to select a suitable meeting time for the meeting invitees. Each *Fuzzy Personal Ontology* (*FPO*) describes the detailed behavior of each invitee. In addition, the *Fuzzy Meeting Scheduling Ontology* (*FMSO*) is utilized for the laboratory members of the department in the university. The experimental results show that the ontology model is useful for the genetic agent and the meeting scheduling systems.

5. Ontology-based Intelligent Healthcare Agent and Its Application to Respiratory Waveform Recognition

In recent years, the population has been aging gradually, and the number of patients with chronic respiratory disease has grown increasingly; therefore the respiratory healthcare plays an important role in the clinical care. Recently, we present an ontology-based *intelligent healthcare agent* for the respiratory waveform recognition to assist the medical staff in judging the meaning of the graph reading from ventilators. The *intelligent healthcare agent* contains three modules, including the *respiratory waveform ontology*, *ontology construction mechanism*, and *fuzzy recognition agent*, to classify the respiratory waveform. The *respiratory waveform ontology* represents the respiratory domain knowledge, which will be utilized to classify and recognize the respiratory waveform by the *intelligent healthcare agent*. The *ontology construction mechanism* will infer the *fuzzy numbers* of each respiratory waveform from the patient or respiratory waveform repository. Next, the *fuzzy recognition agent* will classify and recognize the respiratory waveform into different types of respiratory waveforms. Finally, after the confirmation of medical experts, the classified and recognized results are stored in the classified waveform repository. We have constructed a medical testing environment for evaluating the presented method, the simulated results exhibit the ontology-based intelligent healthcare agent can work effectively.

6. Ongoing Research Topics

As described in this article, we have applied the ontology to various applications, including the domains of image filtering, news summarization, meeting scheduling systems and healthcare agent. We believe that the ontology will play the more and more important role in the Semantic Web in the future. Now, some further projects are ongoing in my research team in Taiwan, for example, the topics of ontology-based knowledge management system for supporting CMMI assessment, ontology-based healthcare agent, and ontology-based fuzzy image processing.

Acknowledgements

Parts of the research reported in this article were supported by the National Science Council of Taiwan under the grants NSC90-2213-E-309-007, NSC91-2213-E-309-005, NSC92-2213-E-309-005, NSC93-2213-E-309-003, and NSC94-2213-E-024-006, the Ministry of Economic Affairs in Taiwan under Grant 93-EC-17-A-02-S1-029, and the Service Web Technology Research Project of Institute for Information Industry and sponsored by MOEA, Taiwan.

Reference

[1] C-S Lee, Z-W Jian, and L-K Huang, "A Fuzzy Ontology and Its Application to News Summarization," *(SCI) IEEE Transactions on Systems, Man and Cybernetics Part B*, vol. 35, no. 5, pp. 859-880, Oct. 2005.

[2] C-S Lee, S-M Guo, and C-Y Hsu, "Genetic-based Fuzzy Image Filter and Its Application to Image Processing," *(SCI) IEEE Transactions on Systems, Man and Cybernetics Part B*, vol. 35, no. 4, pp. 694-711, Aug. 2005.

[3] C-S Lee, C-C Jiang and Tung-Cheng Hsieh, "A Genetic Fuzzy Agent Using Ontology Model for Meeting Scheduling System," *(SCI) Information Sciences*, 2005. (Accepted)

[4] C-S Lee, Y-H Kuo, C-H Liao, and Z-W Jian, "A Chinese Term Clustering Mechanism for Generating Semantic Concepts of a News Ontology," *Journal of Computational Linguistics and Chinese Language Processing*, vol. 10, no. 2, pp. 277-302, June 2005.

[5] S-M Guo, C-S Lee, and C-Y Hsu, "An Intelligent Image Agent based on Soft-Computing Techniques for Color Image Processing," *(SCI) Expert Systems with Applications*, vol. 28, no. 3, pp. 483-494, 2005.

[6] Y-H Kuo, C-S Lee, S-M Guo, and Y-H Chen, "Apply Object-Oriented Technology to Construct Chinese News Ontology on Internet," *(EI) Journal of Internet Technology*, vol. 6, no. 4, pp. 385-394, 2005.

[7] C-S Lee, J-C Du, Z-W Jian, Y-H Kuo, and C-K Hung "Ontology-based Measurement and Analysis Web Service for Supporting CMMI Level 2 Assessment," *WSEAS Transactions on Information Science and Applications*, vol. 1, Issue 6, pp. 1569-1574, Dec. 2004.
[8] C-S Lee and C-Y Pan, "An Intelligent Fuzzy Agent for Meeting Scheduling Decision Support System," *(SCI) Fuzzy Sets and Systems*, vol. 142, no. 3, pp. 467-488, 2004.
[9] Y-H Kuo, C-S Lee, S-M Guo, and F-T Tu, "Apply FNN Model to Construct Ontology-based Q&A System," *WSEAS Transactions on Communications*, vol. 3, Issue 1, pp. 328-335, Jan. 2004.
[10] C-S Lee Y-J Chen and Z-W Jian, "Ontology-based Fuzzy Event Extraction Agent for Chinese e-News Summarization," *(SCI) Expert Systems with Applications*, vol. 25, no. 3, pp. 431-447, 2003.
[11] C-S Lee, C-P Chen, H-J Chen, and Y-H Kuo, "A Fuzzy Classification Agent for Personal e-News Service," *(EI) International Journal of Fuzzy Systems*, vol. 4, no. 4, pp. 849-856, Dec. 2002.

Chang-Shing Lee received the B.S. degree in information and computer engineering from the Chung Yuan Christian University, Chung-Li, Taiwan, in 1992, and the M.S. degree in computer science and information engineering from the National Chung Cheng University, Chia-Yi, Taiwan, in 1994, and the Ph.D. degree in computer science and information engineering from the National Cheng Kung University, Tainan, Taiwan, in 1998.

From August 2001 to July 2003, he jointed the faculty of the Department of Information Management, Chang Jung Christian University as an Assistant Professor. He became an Associate Professor in the Department of Information Management, Chang Jung Christian University since August 2003. Now he is currently an Associate Professor in the Department of Computer Science and Information Engineering, National University of Tainan, Taiwan. His research interests include intelligent agent, ontology engineering, knowledge management, Web services, semantic Web, and soft computing systems. He holds several patents on ontology engineering, document classification, and image filtering.

Dr. Lee received the MOE's Campus Software Award in 2002, the CJCU's Outstanding Research Achievement Award in 2003, the Outstanding Teacher Award from Chang Jung Christian University in 2004, and the TAAI Advisor's Award in 2005. He has guest edited a special issue for Journal of Internet Technology. He is a Member of TAAI.