Conversational Interface Agents for the Semantic Web – a Case Study

Alexa Breuing
Artificial Intelligence Group
Faculty of Technology
Bielefeld University
33594 Bielefeld, Germany
abreuing@techfak.uni-bielefeld.de

Thies Pfeiffer
Artificial Intelligence Group
Faculty of Technology
Bielefeld University
33594 Bielefeld, Germany
tpfeiffe@techfak.uni-bielefeld.de

Stefan Kopp
Artificial Intelligence Group
Faculty of Technology
Bielefeld University
33594 Bielefeld, Germany
skopp@techfak.uni-bielefeld.de

ABSTRACT
The Semantic Web is about to become a rich source of knowledge whose potential will be squandered if it is not accessible for everyone. Intuitive interfaces like conversational agents are needed to better disseminate this knowledge, either on request or even proactively in a context-aware manner. This paper presents work on extending an existing conversational agent, Max, with abilities to access the Semantic Web via natural language communication.

1. INTRODUCTION
The world wide web has become the most powerful and widely distributed knowledge resource. Yet, most information in the WWW is distributed across representations such as text, images or movies, which do not allow easy access to the semantic content itself or its ontological status. Making information detectable and accessible has thus turned into a major challenge [3], especially for elderly or handicapped people.

At present, this task is primarily carried out by employing keyword-based search engines, which miss the ability to understand and generate natural language to enable an efficient and more intuitive web access. The Semantic Web movement has the potential to overcome this obstacle. In this paper, we present an approach to connect an embodied conversational agent, Max [2], to the Semantic Web.

2. THE CONVERSATIONAL AGENT MAX
Max is a conversational virtual agent that aims to enable natural multimodal interaction with human users. He is based on a cognitive architecture featuring a general-purpose deliberation component that constantly strives to fulfill persistent goals (desires) of the agent by choosing and pursuing plans (intentions) depending on current convictions (beliefs) about the world state. This deliberative component is in charge of dialog management and processing communicative acts. Realized as plans, system responses are generated as answer templates that are augmented with nonverbal behaviors, based on the input of the user's input or the dialog knowledge of the agent. This approach mixes heuristic knowledge about frequent questions to the system, lexical and syntactical knowledge as well as interactional knowledge about dialog. The semantic knowledge, however, is rather implicitly specified by the kind of goals that get raised or the utterances that are directly produced by a matching rule.

3. INTERFACING THE SEMANTIC WEB
The rationale to connect Max with the Semantic Web is twofold. On the one hand, the idea originated from problems with the shallow language processing, which is mainly based on pattern matching. More explicit models of the agent's semantic knowledge, as required for Semantic Web access, can help to overcome problems of the agent's input processing like resorting to a shallow understanding of what user input is about. When embedding these representations in the Semantic Web, Max's natural language processing capabilities themselves will directly benefit from having access to a cornucopia of readily available and semantically annotated information on the web.

On the other hand we believe that Max, then, can be a powerful NLP interface "accepting as input questions formulated in natural language and returning answers on the basis of a given interface [1, p. 2]" to the Semantic Web. Max would combine natural language interaction with access to the highly distributed knowledge in the Semantic Web, and this knowledge could be naturally retrieved by simply asking the agent. In turn, especially the currentness of the information could help to greatly increase the acceptance and utility of the agent. Here, as a first step, we will focus on realizing basic dialog moves for query answering based on Semantic Web knowledge modeling technology.

3.1 Knowledge Model
The knowledge represented in the agent's knowledge base is described by an ontology in OWL DL. In this way, we unify the advantages of an expressive formalism with the adaptation to Semantic Web standards. OWL DL supports the construction of a hierarchy and provides a maximum of expressivity and possibility to reason. Furthermore, modeling knowledge in terms of concepts and relations allows for a semantical description of information and a computationally inexpensive update of the contained information. For a better machine comprehensibility the ontology is serialized in RDF/XML syntax.

3.1.1 Lexical and Semantic Knowledge
To process natural language input, the agent's system utilizes both, lexical and semantic knowledge. By using the expressive representation formalism of an ontology, a distinction between these two knowledge categories can be realized. For example, by specifying adequate relations it is possible

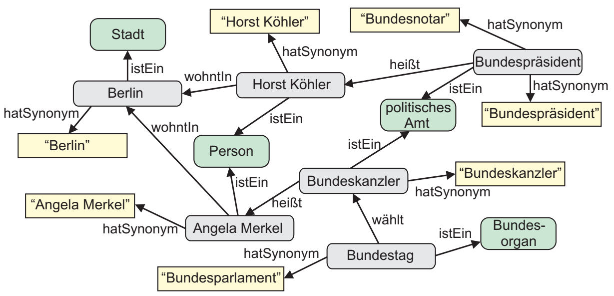

Figure 1: A subset of the ontology of German politics developed for the agent Max. The green colored parts demonstrate classes, the gray ones are instances, the yellow ones are literals and the arrows describe relations. All denotations are German.

to define lexical information like denotations and synonyms for all instances, irrespective of a particular language. In our work we defined the `:hasGermanDenotation` relation to state denotations and synonyms in German. Besides the opportunity to explain lexical information, this approach enables the knowledge model to be independent of the natural language used to communicate with the interface agent. Support for other languages can be added in a straight-forward manner.

To model the semantic knowledge and refine the natural language processing, we started by creating an ontology about the German political system, a knowledge domain that is characterized by a clear ontological structure as well as a high degree of actuality. Fig. 1 shows a small subset of the defined concepts and relations. The current ontology contains about 40 classes, 300 instances and 50 relations. Advanced technologies for an autonomous exploration of the Semantic Web will be implemented in future.

3.2 Architecture

The previously described knowledge base is integrated in the existing deliberative component of the system and its language processing steps as shown in Figure 2. In a first step, the registered user question is forwarded to the preprocessing module. After removing punctuation marks and searching for proper nouns the preprocessed string is sent to the translation module. By accessing the knowledge base, this module converts the input string iteratively into adequate query units for the knowledge base defined in OWL DL. Due to its similarity to SQL and the fact that it became the standard for the Semantic Web, we chose SPARQL as query language.

The resulting query units are committed to the next module that finally composes the full query. This is then executed against the knowledge base and returns the available information, which are forwarded to the answer generator. Within this work the answer is returned directly to the user without a complete generation process. Thereby, the up-to-dateness of the contained information, and thus of the answer for the user, can be ensured by a regular, automatic update of the knowledge base. Figure 2 presents an approach for such an update module monitoring for possible changes in external sources. Currently, we employ an hard-wired update of single pieces of the ontology from predefined

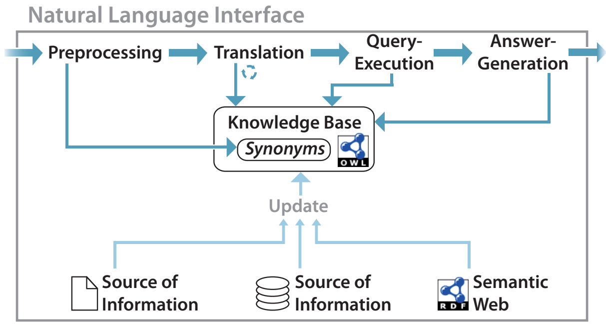

Figure 2: Several processes interact with the personal knowledge base of Max. The top part shows the processes involved in the natural language interface. These processes and their interaction with the newly defined knowledge base realized in OWL DL are in the focus of this poster abstract. The bottom part outlines information sources that could be used to automatically update the knowledge base.

knowledge sources in the web. Other methods will be considered in future work.

4. CONCLUSION

Conversational interface agents provide an intuitive and convenient way to interact with knowledge systems and thus have the potential to tap the knowledge available in the web for everyone. In this paper we presented first steps to equip the well-established embodied conversational agent Max with deeper conversational knowledge by accessing and using Semantic Web technologies. In this, we were particularly interested in the process of translating user questions raised in German into SPARQL queries to knowledge sources specified in OWL DL, and we succeeded in implementing first question-answering functionality for a domain of German politics. From a knowledge engineering perspective, we found that the Semantic Web community provides powerful SDKs, e.g. the Jena SDK, and tools, e.g. Protége, that proved to enhance our productivity in modeling Max' knowledge.

5. REFERENCES

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