Chen, W. et al. (Eds.) (2017). Proceedings of the 25th International Conference on Computers in Education. New Zealand: Asia-Pacific Society for Computers in Education

Using Dialogues with Humanoid Robots for Information Retrieval in an Online Learning System

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Abstract: A humanoid robot can be used as a partner in classroom learning. This study attempts to use an online learning system as an information source in a classroom with a humanoid robot, NAO, providing the verbal interface of the system. The dialogue between a human user and the robot plays a role of presenting knowledge along the lecture context.

To enable the learning system to "talk", we built a Topic Maps (ISO/IEC 13250:2002) ontology of the knowledge provided by the system. In the Topic Maps ontology, subject topics are interconnected with specific associations. NAO connects to the online system through a topic map remote access protocol. Various types of associations among the topics are defined. These associations shape the dialogues linking the specific topics and data provided by the system.

Keywords: Topic Maps, online learning system, humanoid robot, NAO

1. Introduction

Natural language is expected to become a practical user interface for information systems. The design of dialogues as a human-computer interface will become an important field of research (Luppicini, 2008). Human-like communication is desirable for elderly care, autism support, and education (Dautenhahn et al, 2005). To this end, humanoid robots can be used because such robots make use of image sensing to detect individual humans while the gestures of the robot give the robot the characteristic of humorous expressiveness.

In this study, a humanoid robot is used as the partner of a human lecturer. The robot functions as an interface of an online learning system that is part of an e-learning system. An online learning system was constructed using a Topic Maps (ISO/IEC 13250:2002) ontology, which provides structured knowledge as the backbone of the learning system. This paper describes a way of using association types to construct human–humanoid dialogues.

2. Method

The humanoid robot used in this study is NAO (SoftBank Robotics), with Choregraphe as its programming environment. The memory modules, known as "ALMemory", of NAO are available for controlling the robot's behaviors. Text data obtained from the learning system is stored in the memory modules for use in the robot's speech. In this study, the "behavior", which is defined as the robot's action, is programmed into the robot. A complex dialogue is constructed using "QiChat Script", by which sets of words that are to be recognized and spoken by the robot are defined as "concepts." The robot's behaviors are triggered when the robot recognizes these concepts, which can be updated using "dynamic concepts" to enable the renewal of dialogues.

The online learning system is developed using Topic Maps, which is an indexing technology standard. The ontology of Topic Maps is constructed using interconnected "topics". Such interconnections are known as "associations." The topics are also connected to actual information resources or data. These connections are known as "occurrences." By defining the types of topics,

associations, and occurrences in the system, rich data structures can be constructed. A topic map development environment, Ontopia, includes a built-in topic map query language, known as "tolog" and uses a topic map remote access protocol (TMRAP) for tolog queries made via URL queries.

3. Results and Discussions

The basic dialogue pattern expressed in QiChat script is u:({human utterance}) {humanoid speech}. A human utterance is processed by the robot's speech recognition system. The list of starting words for the human utterances is downloaded when the dialogue application is started. The basic parameter of the human utterances is the names of the topics. The starting set of the topic names are retrieved from a particular knowledge domain. As the dialogue proceeds, the set of topic names is re-retrieved.

The basic dialogue pattern is implemented as u:([dynamic concept] + (key phrase)) ^runBehavior(BehaviorName), in which the dynamic concept is renewed by the preceding behavior, and the type of successive behavior is selected by the key phrase added to the topic name. Note that the key phrase is added behind the topic name in the case of the Japanese language, such as, {topic name} + "No Jikken Wa?", whereas the phrase precedes the topic name in English, as, "What is the experiment of" + {topic name}, correspondingly.

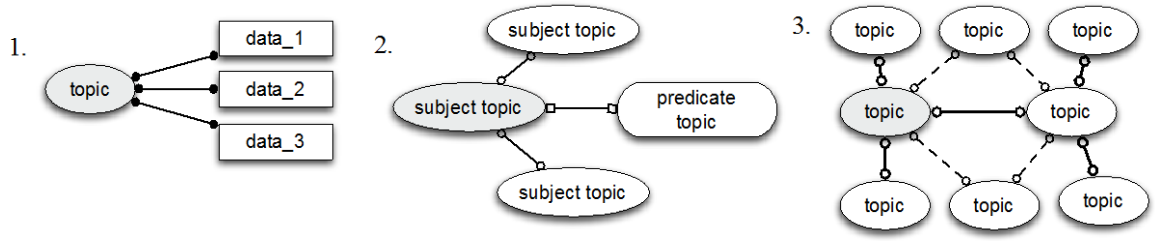

Figure 1. Three basic types of dialogs. The gray topic indicates the starting word recognized by the humanoid robot **1**: occurrence-type dialog **2**: subject-predicate-type dialog **3**: topic-topic-type dialog.

The behaviors are mainly characterized by the types of associations used to send TMRAP query requests. Figure 1 depicts the three fundamental types of topic requests. Figure 1.1 depicts the behavior of an occurrence request. The robot requests internal data such as the description of a topic for a starting topic (indicated in gray) in the dynamic concept. Figure 1.2 depicts the predicate request type. Here, the starting subject topic is described by a predicate topic instance. Figure 1.3 shows a request of associated subject topics. In this case, one of the associated subject topics should be chosen by the succeeding dialogue while the list of associated topics is kept in the memory.

4. Conclusion

An online learning system based on Topic Maps ontology and using a humanoid robot for retrieval is under construction. Since the Topic Maps ontology is constructed by a human lecturer, dialogue patterns with the robot do not change unless the topic map is renewed.

Acknowledgements

This work was funded by a Grant-in-Aid for Scientific Research (C) 15K00912 from the Ministry of Education, Culture, Sports, Science and Technology.

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