

# Using a dialogue system based on dialogue maps for computer assisted second language learning

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and Yunkeun Lee<sup>4</sup>

**Abstract.** In order to use dialogue systems for computer assisted second-language learning systems, one of the difficult issues in such systems is how to construct large-scale dialogue knowledge that matches the dialogue modelling of a dialogue system. This paper describes how we have accomplished the short-term construction of large-scale and machine-readable dialogue maps that match the modelling of a dialogue system. The dialogue map is a kind of graph consisting of sub-tasks, instance-to-slots, and constraints such as ‘necessary’ or ‘optional’. It took 5.36 months to implement a dialogue modelling in the existing dialogue system.

**Keywords:** dialogue map, dialogue system, dialogue system based on dialogue maps, computer assisted second language learning.

## 1. Introduction

A dialogue system is a computer system able to converse with a human. This system has clear potential for Computer-Assisted Language Learning (CALL) that places the second-language learner in a practical situation where a specific task has to be accomplished in the foreign language. Dialogue systems can be divided into two main classes: task-oriented and chat-bot systems. Task-oriented dialogue systems provide a framework for users to have conversations with a machine to do a task such as reserving a hotel or giving bus schedule information (Raux & Eskenazi, 2004; Young, Gašić, Thomson, & Williams, 2013). A state-of-the-art of task-oriented dialogue systems is to study a reinforcement learning based

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on Partially Observable Markov Decision Processes (POMDP) and Deep Neural Networks (DNN) that can make speech recognition and the language understanding robust (Henderson, Thomson, & Young, 2013; Young et al., 2013). However, task-oriented dialogue systems were not successfully deployed on a commercial scale because defining the dialogue acts was difficult. A chat-bot system does not aim at processing a task-oriented dialogue, but seeks to make a conversation with one or more human users. Also, the chat-bot system has the limit of repetitive response to the same question. To overcome this issue, a state-of-the-art of chat-bot systems is to extract the personal information from user utterances and to apply the personal information to a chat-bot conversation (Matter & Wachsmuth, 2014; Kim et al., 2015). This paper concentrates on the task-oriented dialogue system (hereafter, dialogue system) that is closely related with a dialogue-based CALL system. One of the difficult issues in these systems is to construct large-scale dialogue knowledge such as dialogue scenarios that match the modelling of a dialogue system. The existing dialogue modelling had the following weaknesses:

- Small-scale dialogue scenarios, which were manually made by professional educationists for second-language learning study.
- Difficult dialogue acts, which were defined and constructed by experts of dialogue systems.

This paper describes how we have accomplished the short-term construction of large-scale and machine-readable dialogue knowledge that matches the dialogue modelling of a dialogue system.

## **2. Production problem of dialogue knowledge for dialogue systems**

Dialogue systems can talk with users by training knowledge through machine learning. The existing methods to build dialogue knowledge for dialogue systems can be classified into three parts: (1) extracting dialogue knowledge from real dialogue examples (Lee, Lee, & Lee, 2010), (2) building dialogue knowledge from logs of dialogue systems (Hong et al., 2009), and (3) manually making dialogue knowledge (Choi, Kwon, Jeong, & Kim, 2013).

An example of computer assisted second language learning using a dialogue system is GenieTutor (Kwon, Lee, Kim, & Lee, 2015). It was made with the purpose of English learning for Korean people and showed the correction of grammar errors

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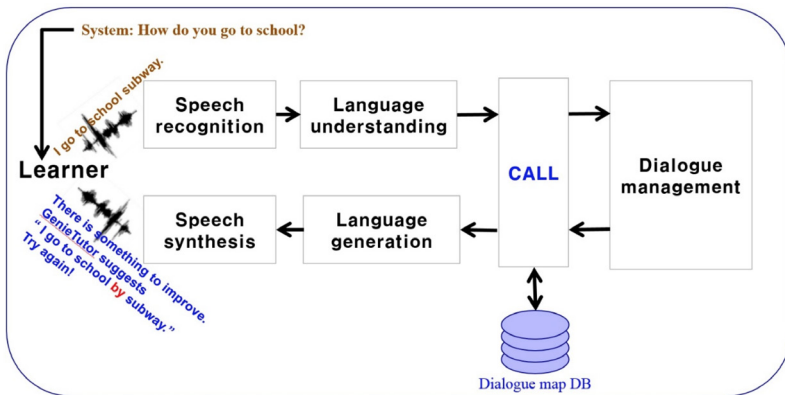
and the overall feedback in fixed dialogue situations. In order to make diverse talk with Korean learners, GenieTutor needed large dialogue knowledge operable on dialogue systems. Acts were coded in the knowledge of GenieTutor. Dialogue flow was constructed by experts who know GenieTutor. It took 5.36 months to choose a task and build the whole dialogue knowledge of the task. So we could not help building a small quantity of dialogue knowledge. GenieTutor talked with Korean learners at a constricted level of dialogue and gave feedback to limited grammar error correction.

### 3. Construction of dialogue map and discussion

#### 3.1. Position of dialogue map

Dialogue map is a database in which sub-tasks of a task and dialogue turns of a sub-task build a form of graph. Dialogue knowledge automatically extracted from the map is used in dialogue understanding and management. Figure 1 shows the position of the dialogue map in GenieTutor.

Figure 1. Position of dialogue map in GenieTutor



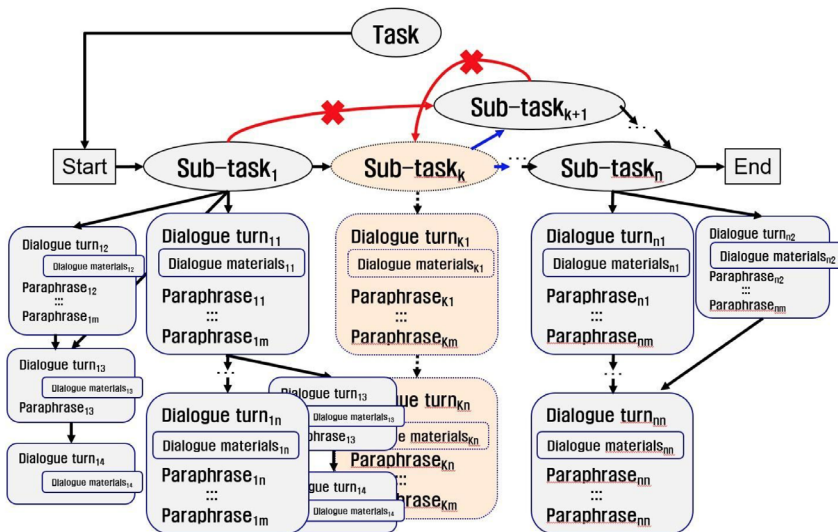
GenieTutor is a kind of hybrid system consisting of a dialogue system and a CALL system. Its dialogue system is made up of speech recognition, language understanding, dialogue management, language generation, and speech synthesis. Its CALL system is located between the language understanding module and the

dialogue management module and takes charge of the second language learning. The dialogue knowledge of both the language understanding module and the dialogue management module are trained from the dialogue map database. The dialogue map database could be made by educators who do not know a dialogue system.

### 3.2. Configuration of dialogue map

A dialogue map consists of the following: tasks, sub-tasks that constitute a task, dialogue materials that compose each sub-task, turns including the materials, and paraphrases which are equivalent to a meaning of dialogue turn. A sub-task can have his subordinate sub-tasks. Sub-tasks can make diverse dialogue paths through constraint operators that decide whether a sub-task is necessary or optional within a task and protect reverse order among sub-tasks. Figure 2 shows a structure of a dialogue map.

Figure 2. Structure of dialogue map



For example, let us assume a task 'ordering food'. This task can be consisted of some sub-tasks like 'Start -> greeting -> choosing main dishes -> ordering side dishes -> asking for the bill -> saying good bye -> End'. The sub-task 'choosing main dishes' would be filled with the following dialogue turns between system and user:

Task: 'ordering food'

Sub-task: 'choosing main dishes'

Dialogue materials: 'omelette', 'steak and eggs', 'French toast'

Dialogue turn:

System: "What would you like to order?"

User: "I would like to have the omelette."

Paraphrase: "I'll try the omelette."

System: "We have two kinds of omelettes, mushroom and cheese. Which one would you like?"

User: "I would like to have the mushroom."

### 3.3. Method of construction of dialogue map

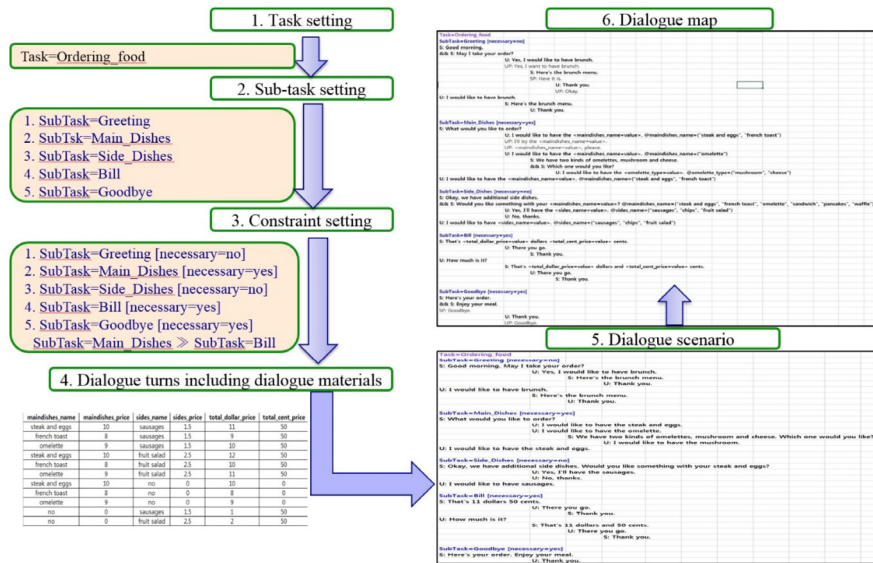
Professional educators build the dialogue scenarios. By using an authoring tool, they would make maps from scenarios. The authoring tool is under development.

First, dialogue scenarios can be produced by the following procedure: (1) set a task, (2) set the sub-tasks, (3) set the constraints, and (4) input dialogue turns including dialogue materials. A sub-task can also possess its subordinate sub-tasks. Sub-tasks are similar to concept of script of [Schank and Abelson \(1977\)](#) because scripts are structures of actions that describe a chain of events in a certain situation. Dialogue materials means core vocabularies of dialogue turns that second-language learners have to learn. Dialogue turns are sentences of talking between system and user and are constructed by dialogue materials of a sub-task. Paraphrases are built on the basis of a representative dialogue turn.

After constructing scenarios, we can make a dialogue map from the dialogue scenarios through an authoring tool with the following functions: (1) convert sentences of a scenario to the format of a dialogue map, (2) replace the materials with slot variables of the dialogue system, (3) automatically generate dialogue acts from sentences, (4) mark the command to directly move from a sentence to a sub-task, (5) show the calculus that calculates price, sums the number, and (6) visualize whole dialogue map. [Figure 3](#) shows a sample of a dialogue map that was built from a dialogue scenario with a task 'ordering food'.

A dialogue act is automatically generated from a sentence. For example, the dialogue act of the sentence 'I would like to have the <maindishes\_name>. @maindishes\_name = {'steak and eggs', 'french toast'}' is 'would\_like\_to\_have\_maindishes (maindishes=steak\_and\_eggs)' which consists of a verbal phrase and a noun phrase like first order logic.

Figure 3. A sample of dialogue map of a task ‘ordering food’



**3.4. Discussion**

As mentioned in section 2, it is less time consuming to construct a dialogue map, as opposed to dialogue knowledge within an existing dialogue system. These maps connect first to a dialogue system and operate normally as a core knowledge base of dialogue-based CALL systems. The duration of constructing a dialogue map should get shorter because in the near future we will provide the educationists with an authoring tool to (1) systematically construct the dialogue scenario, (2) automatically convert a sentence into a dialogue act, (3) semi-automatically replace dialogue materials with slot variables, and (4) visualize the whole dialogue map.

**4. Conclusions**

This paper describes the dialogue-based CALL system based on dialogue maps. The format and construction method of dialogue maps were detailed. The authoring tool for constructing a dialogue map is under construction. Our goal is that a duration of construction of a dialogue map is reduced from a month to two weeks. We are planning to expand the tasks of dialogue maps which are not fixed, but are free.

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