Episodic Memory Design for Predicting the User's Intention

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Abstract. These days, people can easily access various services through IT devices. However, in most cases, the user has to spend much time in configuring the right options to get the exact desired service. To solve this problem, this paper proposes a service system with the episodic memory for predicting the user's intention. The interaction module is the main module which is developed for seamless and interactive service, and it contains the episodic memory and the service information. The episodic memory records the history of the user's pattern when the user utilizes the service agent. The service information is a set of essential data for providing services. Also, the reliability of the episode memory is proposed for predicting user's intention. The effectiveness and applicability of the proposed system are demonstrated through the experiments.

Keywords: episodic memory, intention prediction, interactive service

1 Introduction

In recent years, various IT devices have been developed and they provide many services to people. The news, expert knowledge, and entertainments are easily accessible through the internet and PC. Mobile devices including smart phone provide various services at anyplace and anytime. Naturally, people, these days, spend much more time to get better service than in the past. However, in most cases, the user has to select options to take the exact service. When the television is turned on, it does not select the channel automatically because it does not know which channel the user wants. Therefore, the user has to select the channel manually. However, if the television is able to understand the user's intention, then it can provide more convenient service to the user.

Lately, there have been research on user intention recognition method to offer a personalized and seamless service for web-browsing [1]-[4], smart home systems [5], [6], healthcare [7], and human-robot interaction [8], etc. The service patterns of the user to build ontology or to cluster users' patterns have been used. Besides, many websites use the cookie which is a piece of text stored on the user's computer by the web browser. It can be used for storing site preferences, shopping cart contents, or anything else that can be accomplished through strong text data. The online shopping site provides the list of products

which are searched by the user or recommended based on shopping patterns of the user. This kind of services needs to interact with the user because they should be updated whenever an undesired service is provided. From this point of view, the interaction between humans is a good guideline. At a restaurant, for example, a customer can choose from many options when he orders a food. Usually, a waiter asks each option one by one. However, a waiter may ask"as usual?" if the customer visits the restaurant often. Most people feel comfortable to the question because it is common in daily life.

This paper proposes the episodic memory design for predicting the user's intention. The user's intention prediction algorithm is implemented to the interaction module which contains the episodic memory and the service information. The episodic memory records the history of the user's pattern when the user utilizes the service agent. The service information has essential data for providing services. The structure of the episodic memory and the reliability of the episode memory are proposed to predict user's intention. Additionally, the system tries to talk with the user to provide a proper service as is done between humans. Each module and each agent were developed based on modular design approach and, therefore, the proposed system can be easily applied to other systems as well.

The remainder of this paper is organized as follows. Section II describes the data structure for episodic memory and maintenance processing. Section III proposes the system for service and its algorithm. In Sections IV, the experimental results are described. Finally, the concluding remarks follow in Section V.

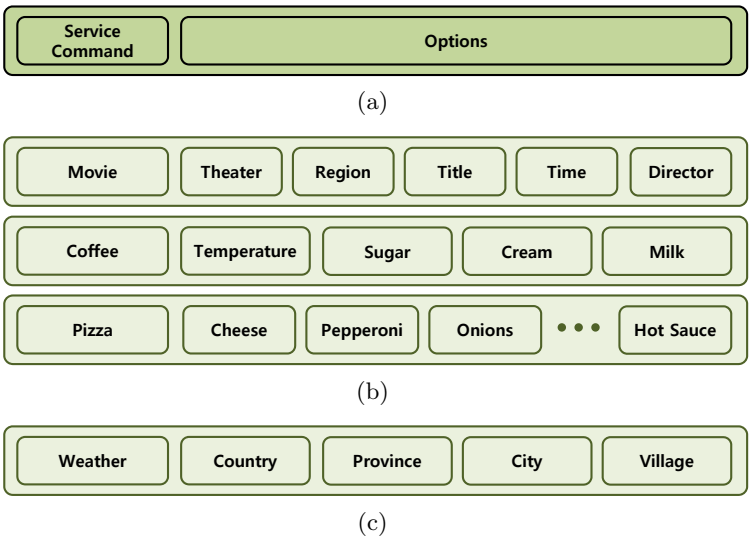

Fig. 1. (a) The structure of the service information. (b) The example structures of the services about movie tickets, coffee, and pizza. (c) The example structures of the service about weather forecast.

2 Episodic Memory

Most of services consist of a main command and options. The episodic memory stores the each value of options and the time when the service is provided successfully. It recommends proper options automatically when the user requests the same service again. Therefore, it makes possible to provide seamless service to the user.

2.1 The structure of the service information

The service information is a set of essential data for providing services. There are two types of the service information and both one are consist of 'service command' and 'options' as shown in Fig. 1(a). The first one is that the options of the service information represent the result of the service itself. For example, the services for movie tickets, coffee, and pizza contain all information for service even though they are not physical results as shown in Fig. 1(b). The second one is that the options of the service information are key values to make the result of the service. The service information about weather forecast has four options to represent the address as shown in Fig. 1(c). They are used as key values to access the database which has the weather information.

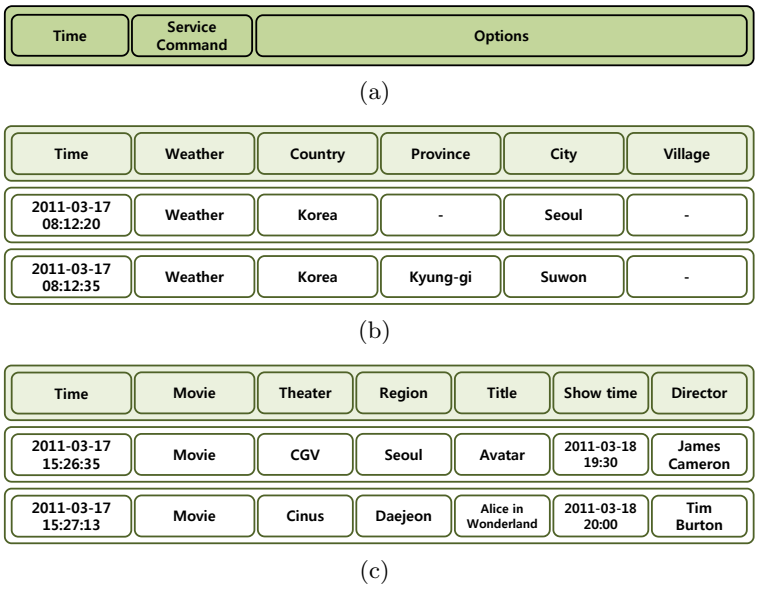

Fig. 2. (a) The structures of the episode. (b) The example episodes of weather forecast. (c) The example episodes of the advance sale of movie tickets.

2.2 The structure of the episode

The structure of the episode is similar to one of the service information because the episode is a history of each service. It additionally has 'time' field which records the time when the episode was occurred. Fig. 2 shows the example structure of the episode. The episode may have null value for several fields because it is possible to skip the selection of several options by users choice.

2.3 Maintenance

Whenever the user interacts to a service agent, the episode is occurred. However, the episode which is occurred when the service is provided successfully is only meaningful and it is recorded to the episodic memory. Also, the episode should be removed from the episodic memory to adapt to the users new pattern. Every episode is removed after predefined episode life time such as one week or one month.

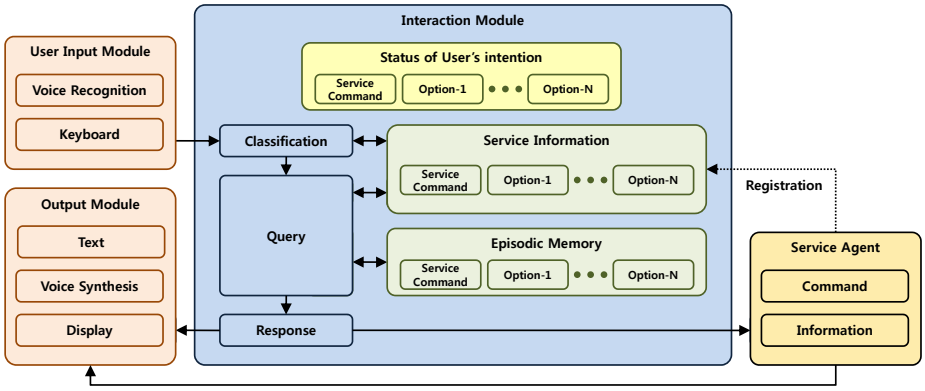

Fig. 3. Overall system for predicting the user's intention by using episodic memory.

3 System for services

The proposed system consists of the user input module, the output module, the interaction module, and the service agents (Fig. 3). The user input module transfers text or voice data from the user to the interaction module. The output module transfers interaction data from the interaction module to the user. Also, the service results from the service agents are shown to the user though the output module. The service agent should be activated itself by registering the service information to the interaction module.

The interaction module updates the status of user's intention by using the service information and the episodic memory. It reports the selected service

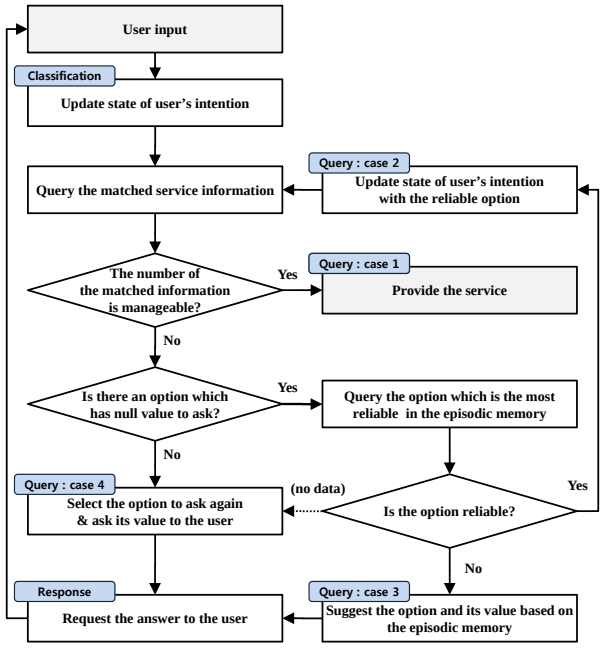

Fig. 4. The flowchart of interaction-based service providing.

to a proper service agent when the status of user's intention has enough valid option values to decide the service. The status of user's intention is updated by classification, query, and response processes (Fig. 4). The processes are briefly described in the following.

3.1 Classification

The classification is the first step of the processes when the user inputs new data. The input data is compared with each value of the service information. If the input data is the service command, then the status of user's intention is initialized and a new service command is assigned. If it is a value of an option, then it is assigned to the corresponding option of the status of user's intention. When the interaction module asks a question with the expected answer to the user, it can be an answer such as "yes" or "no." In this case, the expected answer is assigned instead.

3.2 Query

The query is the step for predicting the best service based on the status of user's intention. The interaction module searches for the matched data in the service information which satisfies the status of user's intention. If the number

of the matched information is manageable, which means it is possible to output for providing service, then the results are reported to the corresponding service agent (Case 1). The maximum amount of data that can be managed by the service agent is defined and it is settled when the service agent was registered to the interaction module. If there are too many searched data, it means the status of user's intention needs a more specific value for options. If there is an available option in the status of user's intention, the interaction module finds out the option value which has the highest reliability in the episodic memory. The reliability of episode e, $R_e(e)$, and the reliability of the option value v, $R_v(v)$, are defined as follows:

$$R_e(e) = \frac{e_t}{T}, \tag{1}$$

$$R_v(v) = \frac{\sum_j R_e(e'_j)}{\sum_i R_e(e_i)} \tag{2}$$

where e_t is the residual life time of episode e, T is the life time of an episode, $E = \{e_1, e_2, ...e_N\}$ is a set of episodes in the episodic memory, N is the number of episodes, $E_v = \{e' | e \text{ has option value } v, e \in E\}$.

The searched option value is assigned to the status of user's intention, if its reliability is greater than predefined thread hold such as 0.6 (Case 2). Otherwise, it is assigned only if the user confirms it (Case 3). If there are not enough episodes in the episodic memory to calculate the reliability, then the interaction module selects the option in order and asks its value to the user again (Case 4).

3.3 Response and service providing

The response process is the transferring step to request the option value to the user. The interaction module transfers the question to the output module and the output module represents it to test message, voice synthesis or an image. Also, the service agent sends the service result to the output module to provide it to the user.

4 Experiments

The dialogue agent, the display agent, two service agents, and the interaction module were implemented for experiments as shown in Fig. 5. The dialogue agent is the program which connects the interaction module and the user through text and voice interface. Two service agents, the weather forecast agent and the movie ticket agent, generates the result image and sends it to the display agent. The user takes a service through the displayed image.

4.1 The weather forecast

4.1.1 Service information and episodic memory

The service information of the weather forecast agent consisted of three options which were 'city,' 'gu,' and 'dong' as shown in Fig. 6. These are the unit of

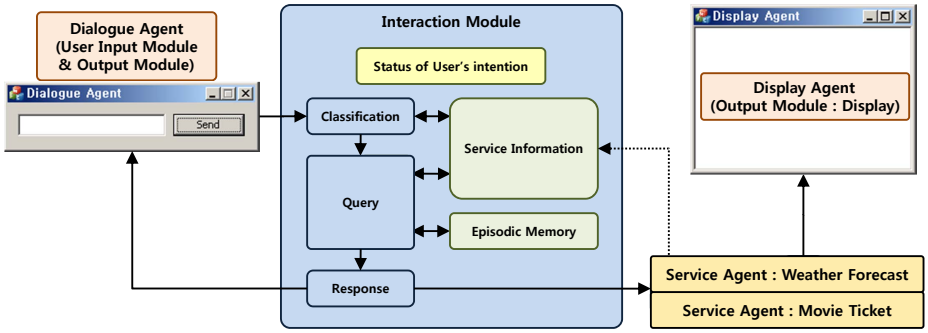

Fig. 5. The system setup for experiments.

Fig. 6. The structure of the service information of the weather forecast agent.

the administrative district of Korea. The maximum amount of data that can be managed by the weather forecast agent is defined by 1.

4.1.2 Weather forecast agent

When the address information from the interactive module is transferred, the weather forecast agent downloads the corresponding XML data from the internet portal site. The XML data has the information of 'temperature,' 'probability of rain,' 'direction and speed of wind,' and 'humidity' for every three hours during 48 hours from now. This information was represented with the image and it was transferred to the display agent.

4.1.3 Analysis

Fig. 7 shows the experimental results of the proposed system with weather forecast agent. The service was provided when the user inputted the all option value in order at first (Ex. 1-1). After the episodic memory stored several episodes, the service agent tried to interact with more natural communication. The agent suggested 'Daejeon' and 'Yuseong-gu' because they were the most reliable values for this service (Ex. 1-2). Finally, the agent automatically provided the weather in 'Daejeon Yuseong-gu Guseong-dong' without any question (Ex. 1-3).

4.2 The advance sale of movie tickets

4.2.1 Service information and episodic memory

The service information of the movie ticket agent was consisting of eight options which are 'region,' 'theater,' 'theme,' 'date,' 'time,' 'director,' 'actor,' and

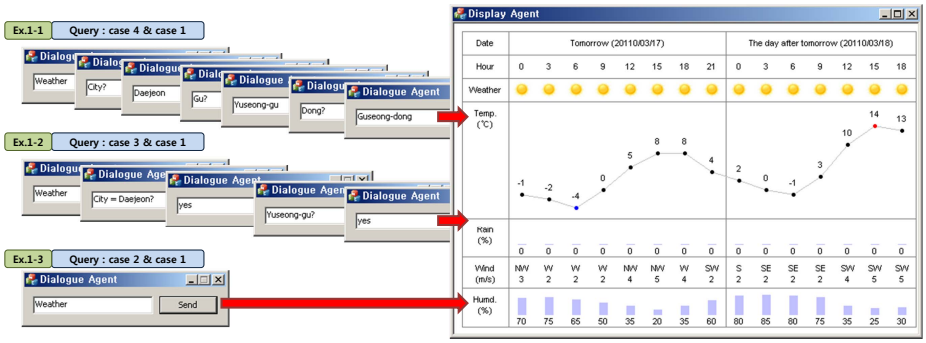

Fig. 7. The experimental results with the weather forecast agent.

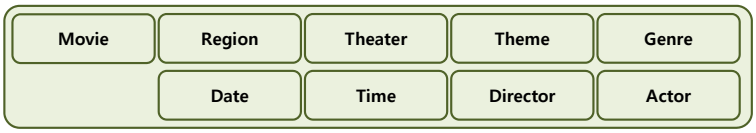

Fig. 8. The structure of the service information of the movie ticket agent.

'genre' (Fig. 8). The information of the ticket is needed in the interaction module because the service information is the service result itself. Therefore, the data for the service information were collected from internet portal site by using HTML parser before this experiment. The maximum amount of data that can be managed by the movie ticket agent is defined by 10.

4.2.2 Movie ticket agent

When the service information from the interactive module is transferred, the movie ticket agent represents the information to the image and it is transferred to the display agent.

4.2.3 Analysis

Fig. 9 shows the experimental results of the proposed system with the movie ticket agent. Like the experiment with the weather forecast agent, the service was provided when the user inputted the all option values in order at first (Ex. 2-1). After the episodic memory stored several episodes, the service agent suggested reliable option value 'Seoul' instead of asking in order (Ex. 2-2). Finally, the agent automatically provided the ticket information without any question (Ex. 2-3).

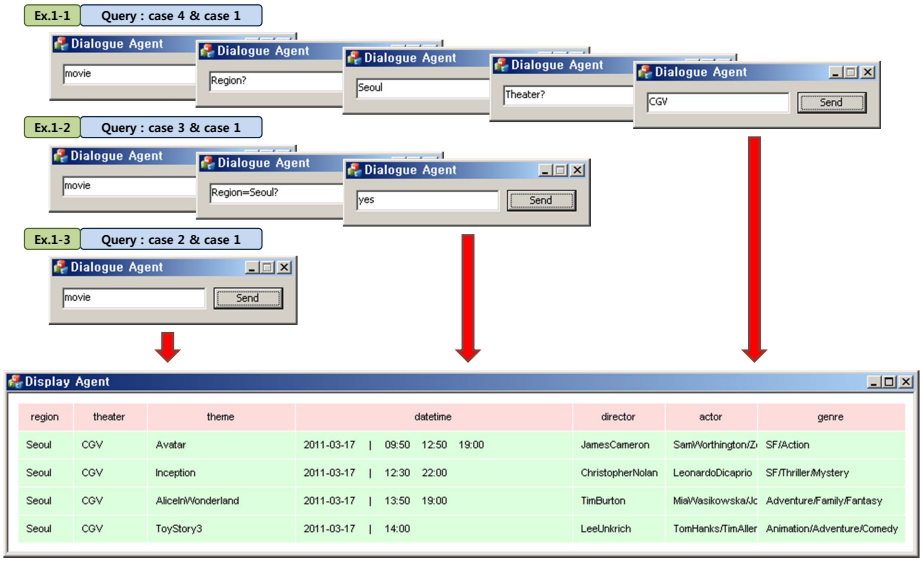

Fig. 9. The experimental results with the movie ticket agent.

5 Conclusion

This paper proposed the service system with the episodic memory for predicting the user's intention. The structure of the service information and the episodic memory were defined and implemented. The reliability of the episode memory was proposed to predict user's intention. Two different types of software agents were implemented for the experiments. Also, the research showed natural and convenient service system successfully by providing the interaction between the prediction algorithm and the user. Moreover, the proposed system can be easily applied to other systems because the user input, the output module, the software agent and the interaction module were developed independently. As further works, the algorithm for predicting user's intention should be improved because the reliability does not consider the relation among options.

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