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Exploration of WeChat-based Legal Robot

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Abstract. To study the legal robot based on WeChat, the construction and implementation of the model-based Chinese pronoun digestion overall algorithm framework were elaborated. Then, the overall structure, module design and system display of the system were introduced in detail, and pronoun resolution and omission recovery module were explained. In practice, the long-term and short-term memory network model learning suitable for serialization input was used to express the deep characteristics of the context and applied to the Chinese pronoun resolution and omission recovery tasks respectively. In addition, the effectiveness of the Chinese pronoun disambiguation technology and the pronoun ellipsis recovery technology in the intelligent robot system was discussed, and a targeted analysis and optimization of the semantic complement task were made. Finally, an intelligent legal robot system based on the WeChat platform was realized.

1. Introduction

WeChat is a mobile application launched by Tencent in 2011 on a smart terminal platform that can provide users with instant messaging services [1]. The most important branch of WeChat is the support of network transmission services, which can quickly send voice messages and text messages through the Internet. This situation provides powerful platform support and user protection for legal robots based on WeChat R&D, and also provides corresponding technical support [2].

In the natural language interaction with legal robots, humans naturally follow the language habits of communicating with people, and still use pronouns to refer to or directly omit some key information according to the context [3]. It is particularly prominent in everyday chat conversations and simple information exchanges, making it difficult for robots to respond accurately. Therefore, pronoun disambiguation and omission recovery must be performed on the user input first to supplement the missing semantics or grammatical components, so as to better complete the understanding of the dialogue and provide interactive feedback.

2. Literature Review

The study of legal robot began with the Turing Test proposed by Alan M. Turing in 1950, known as the "father of artificial intelligence". If a machine can talk to humans and cannot be identified, then the machine is said to have intelligence [4]. With the continuous development of natural language understanding techniques and the gradual construction of large-scale knowledge bases, the legal robot system has received extensive research and attention. Law robots are generally divided into five categories: online customer service, entertainment, education, personal assistant, and intelligent question and answer. They are deployed on homepages, social media, smart toys, and mobile terminals. In different application scenarios, natural language interaction with users or corresponding operation is performed. The common legal robot systems on the market include Microsoft's "Xiaobing", AppleSiri, and Baidu "mystery" [5-6]. At present, the accuracy and anthropomorphism of intelligent robots have made great progress. However, it is difficult to solve the problem of understanding natural language questions accurately and achieving semantic analysis and semantic understanding in the context of context. Common legal robots are still based on question answering systems [7-8].

3. Methodology

3.1 Gradient Boosting Decision Tree

Gradient boosting decision tree (GBDT) is also called as multiple additive regression tree (MART). It is a decision tree algorithm applying iterative strategy. The algorithm consists of multiple classification and regression tree (CART). Each tree will give a real-valued prediction of the input sample, and the final classification result will be obtained by adding up the conclusions of all the trees. Due to this feature, the model has a strong generalization ability and is not easily overfitted. Formally, each tree uses the minimum mean square error as a criterion to find the segmentation threshold of the optimal segmentation variable. For the input training set (X, Y), the solution formula is as follows:

$$\min_{j,s}[\sum_{x_i \in R_1(j,s)}(y_i - c_1)^2 + \sum_{x_i \in R_2(j,s)}(y_i - c_2)^2 \tag{1}$$

In the formula, j represents the j-th dimension feature. s represents the segmentation threshold of feature j. c_1 and c_2 represent the current node's predicted value. R_1(j, s) and R_2(j,s) represent a subset of the training set divided by feature j at the threshold s.

Specifically, the set expression of R_1 and R_2 is shown in formula (2), and the calculation formula is shown in (3):

$$\begin{aligned} \mathrm{R}_1(j,s) &= \{x \mid x_j \le s, x \in X\} \\ \mathrm{R}_2(j,s) &= \{x \mid x_j > s, x \in X\} \end{aligned} \tag{2}$$

$$\begin{aligned} c_1 &= ave(y_i \mid x_i \in R_1(j,s)) \\ c_2 &= ave(y_i \mid x_i \in R_2(j,s)) \end{aligned} \tag{3}$$

In the formula, X represents the training sample set and ave represents the averaging operation.

3.2 Article Neural Network

In the neural network model, there are two or more layers of organizational structure, including hierarchical links and intra-layer links. The strength is expressed using the weights of the links. Taking a simple three-layer neural network as an example (as shown in figure 1), there are input Layer, output layer and hidden layers. The neurons in each layer are called input nodes, output nodes and hidden nodes. They are generally composed of an adder and an activation function. The number of hidden layers of the neural network and the number of nodes in each hidden layer determine the complexity of the network model and affect its processing speed and operating efficiency. Neural networks use back propagation (BP) algorithm for training. The key is to update the weight parameters of each link in the model.

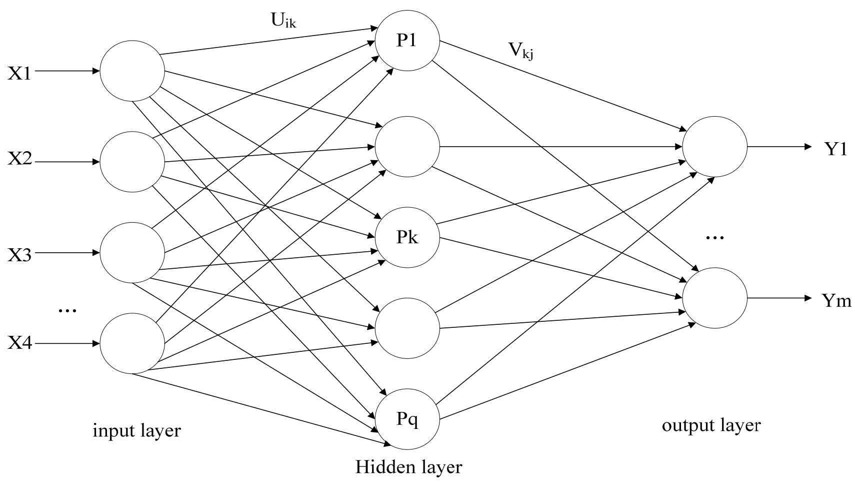

Figure. 1. Neural Network structure

In this paper, neural network classifiers are used to experiment different features and their combinations. On the one hand, neural networks have stronger ability to fit nonlinear boundaries. On the other hand, they have better adaptability to the features of word vectors. The structure of the fully connected neural network used in this paper is shown in figure 2. The input consists of four parts, including the digestion pronoun X_p and the candidate lead X_a and its context.

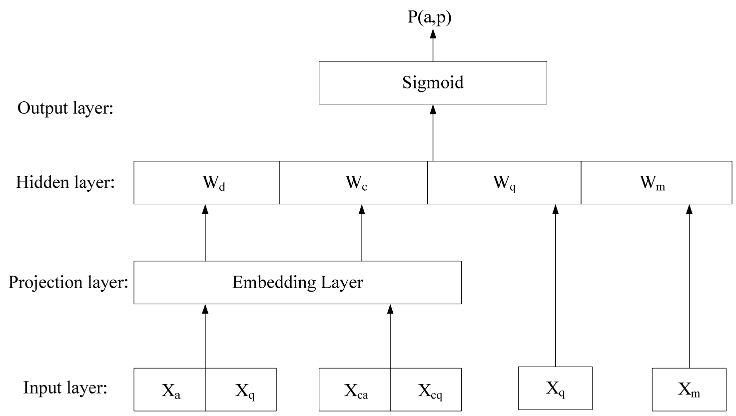

Figure. 2. Neural network model in digestion of Chinese pronouns

3.3 Decision Support System

The core component of the decision support system is the data warehouse. The data warehouse exists in the decision support system. It not only integrates a large number of modern information technology applications, but various data mining computing environments in the application process. In other words, the system uses the platform to aggregate all the value information and data needed by all businesses into a relational database, and then provides valuable information to decision makers through specific topic patterns. In the process of data storage, classification, mining and analysis, the data organization and operation methods in the data warehouse can be improved to some extent. The ultimate goal of improvement is to improve the feasibility and accuracy of decision making.

In general applications, we use the information gain measure to select split attributes. That is, supposing that there are s sets of data samples S, and the class label attribute is a training data set with n types of samples. Each type of sample has a number of instances of S_i, and the amount of information *I* needs to classify them is:

$$I(S_1,S_2,...,S_n)=-\sum_{i=1}^{n}P_i\log_2(P_i) \tag{4}$$

In the formula, $P_i=S_i/S$ represents the probability that any sample belongs to category C_i.

As shown in figure 3, the decision support system is divided into three parts: the tool layer, the information layer and the database. Among them, the three parts are summarized as two platform interfaces. One is an external application layer and is mainly responsible for providing users with OLAP analysis methods and tools, and data mining functions. The second is the information layer and database. A database is a large storage and processing space that supports all the data and information required by the information layer, so that the information layer and the tool layer can be used before the database. The information layer is the location of data mining, such as clustering, classification and intelligent extraction, which are stored and called by the data warehouse.

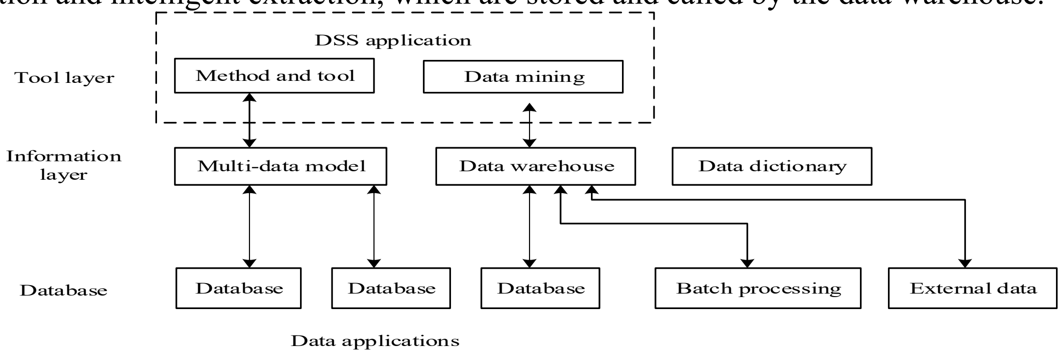

Figure. 3. An architecture for DSS applications

4. Results and Discussion

4.1 Implementation of System Module

In the legal robot system, when the user starts to interact with the system, the problem understanding module aims to understand the semantics of the user input and converts the input into a specific semantic expression. After that, the context dialogue management module judges the problem type and selects the corresponding answer model, transfers to the answer generation module, and maintains the dialogue state. The answer generation module generates or retrieves the corresponding answer text based on the output of the context module, and then feeds back the user with the context module.

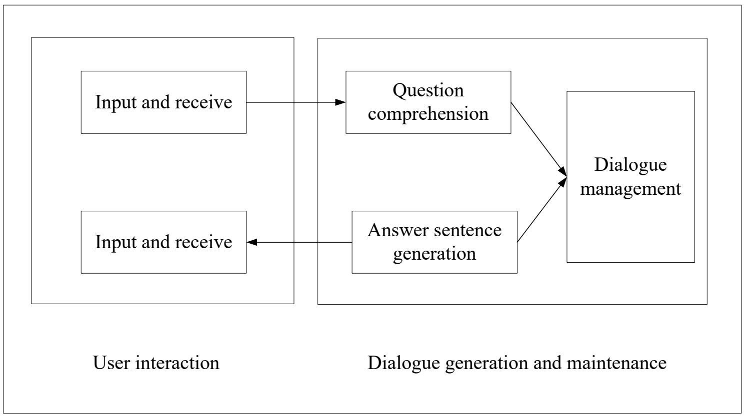

Figure. 4. Legal robot system framework.

WeChat software itself provides a good language interaction environment. In mobile smart terminals, users can easily input natural language text information and receive corresponding text feedback. Therefore, the main task of the system is to use the data received by WeChat to perform pronoun resolution and omit reply completion semantics, and then submit it to the core question and answer module for problem understanding and answer generation. Finally, it is fed back to the user's terminal interface via the WeChat interface. The intelligent legal robot system structure realized in this paper is shown in figure 4. For semantic supplementary module, on the one hand, in the natural language environment, the user's input may be non-standard, so it needs to be processed first. On the other hand, the core modules of semantic supplement and question and answer need to use the basic natural language processing results of the current input sentence, such as word segmentation, part-of-speech tagging and syntactic analysis. Through the analysis of the user's historical record information, the pronoun disambiguation and omission recovery algorithms are invoked on the user's current input to obtain a semantically complete natural language question. Finally, it is delivered to the question and answer core module. For the core module of question and answer, it is responsible for the interpretation of problem sentences after the semantic complementation and the corresponding answer sentence generation. Due to the open-language environment and chat topics, a trained legal robot model is more effective. For the dialogue management module, it is responsible for maintaining the user's history information and is of great significance for context understanding and user intent analysis. Legal robots also need to learn the dialogue's behavioral state, improve the accuracy and fluency of the answer sentences, and optimize certain special scenes accordingly.

4.2 System Implementation

The semantic complementation module includes the tasks of data pre-processing, pronoun resolution and omission reply. It needs to normalize user input. In addition, the natural language processing tool is used to obtain corresponding analysis results. Finally, based on this result and historical information, semantic complementarity is implemented and input into the core question and answer module. The semantic supplement module flow chart is shown in figure 5.

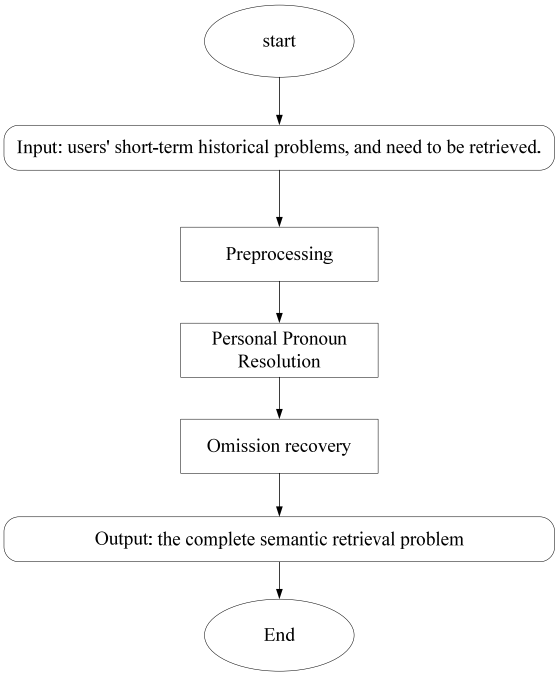

Figure. 5. Semantic supplement module flow chart

Another important function of the dialogue management module is to carry out the information transfer of each module and maintain the dialogue state. Figure 6 is a data flow diagram of the WeChat legal robot system server implemented in this paper. User input is monitored by Wechat and passed to the server via the Itchat interface. The dialog management module starts and maintains the user's history record and sends the message to the semantic supplemental module. The complete question of the semantic supplement is then imported into the Q&A core to generate the reply sentence. The final production answer is then output by the Itchat interface to the WeChat platform, using a PC or mobile display.

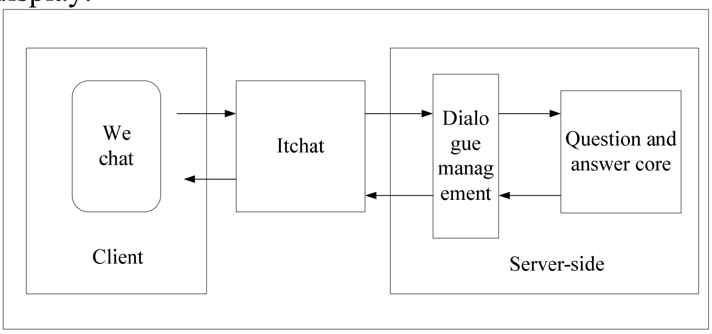

Figure. 6. Server data flow diagram

5. Conclusion

In this paper, features are extracted from several different angles of experience, semantic roles and word vectors to describe the pairs of representations. The result proves that these features are effective for the task of pronoun resolution. In particular, the feature of word vectors is the most significant. This paper focuses on the application of deep learning techniques such as LSTM model in Chinese pronoun resolution and Chinese pronoun abbreviated recovery. It is found that the basic LSTM single-layer structure performs best in the disambiguation system implemented in this paper. The method can further improve the experimental results combining with the attention mechanism.

First, the design and implementation of the smart WeChat legal robot system are described in detail. Then, the system structure and module design of the system are introduced. Third, the detailed description is given according to the divided modules, especially the specific design and implementation steps of the semantic supplement, question and answer core, as well as dialogue management. Finally, the system environment is explained.

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