Comparative Studies of AIML

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Abstract—**At present, the robot, based on AIML, is widely applied in many fields. AIML has become a heavily researched subject. By reading numerous published studies from all over the world, the authors have developed a detailed overview of AIML based on the current research status and development in Chinese applications. This paper is separated into three primary sections: the Introduction of AIML, problems and solutions of AIML in the Chinese treatment, and the application of the AIML. The first part introduces the basic theory, such as the AIML background and reasoning mechanisms. The second part introduces the problems of AIML in the Chinese findings by domestic and foreign scholars and suggests improved treatment methods. This part is the core component of this article. The third part is the application status of AIML technology, which shows that AIML is widely used in the chat robot field. Finally, as previously stated, this paper proposes the development and direction of AIML.**

Keywords-AIML, AIML in Chinese, AIML application.

I. THE INTRODUCTION OF AIML

A. *The Background of AIML*

This language's prototype is a highly scalable Eliza robot called "ALICE" ("Artificial Linguistic Internet Computer Entity"), which was invented by Richard Wallace and the free software community around the world in 1995 to 2002. Using the standard of XML, AIML is a particular language that defines a service in the field of artificial intelligence. Currently, the AIML language has versions of Java, Ruby, Python, C, C #, Pascal, among others.

B. *The Specification of AIML*

AIML is an xml-compatible text file where each type, such as <aiml topic = "professional">, is called an element. Each element is closed; as long as it has <aiml> at the beginning, it must have </ aiml > at the end.

The <aiml> tag wraps the contents of an AIML file. For example,

```
<?xml version="1.0" encoding="UTF-8"?>
<aiml version="2.0">
<category><pattern><SET>COLOR</SET></pattern>
<template><star/> is a color.</template>
</category>
</aiml>
```

The AIML file is an XML file and thus may also have an optional header, such as <?xml version="1.0" encoding="UTF-8"?>; however, the definition of the XML header is outside the scope of AIML 2.0. The <aiml> tag wraps the AIML contents.

The basic unit of knowledge in AIML is a category. The <category> tag always contains an input <pattern> and a response <template>. Optionally, it may also contain a <that> pattern and a <topic> pattern. If either of the <that> or <topic> is omitted, then the AIML interpreter assigns the corresponding pattern a value of *.

C. *The Corpus of AIML*

AIML describes a group of data objects known as AIML objects and describes the program behavior of dealing with these objects. This behaviour is the corpus of the entire chat system [1].

The AIML corpus is saved to the computer's memory in the form of a Graphmaster, which consists of a series of node sets known as Nodemapper. Each Nodemapper has several branches that are called Pattern Path from this node. A Pattern Path is defined as a linked sequence of nodes, where the nodes are linked by edges labelled with the words. The sequence of words in a Pattern Path is specified as the words from the input pattern followed by the symbol <that>, then the words in that pattern followed by the words in the topic pattern. In this way, the Graphmaster can be described as a memory tree in which the number of leaf nodes are equal to the number of patterns in the corpus. The structure of the Graphmaster is similar to the structure of the file system in the operating system. Different patterns can share the same parent Nodemapper if they share the same node in front of the path. Using this knowledge storage mechanism not only can improve the utilization of the computer's memory, but it also can inline AIML files. Thus, many AIML files containing different areas of knowledge can be combined into a corpus to improve the scalability and compatibility of the system [2].

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The chat ability of a robot can be affected by the scale of the AIML corpus and knowledge coverage. Currently, the AIML corpus has begun to take shape in English and French [3]. However, there is little of the AIML corpus using Chinese at present. The reasons are varying: First, the expression of Chinese is different from the Western languages. AIML was originally designed for Western languages, so there was no technical support for Chinese. Second, the order of Chinese words, using more function words, can be free (unlike western languages that have rigid word ordering in sentences), which greatly increases the difficulty of corpus building. Additionally, the building of the AIML corpus needs professionals in this field. Although the AIML language is relatively simple compared to other languages, non-professional programmers have difficulty in mastering it. Finally, the AIML language in the Chinese field currently has less information available for those wanting to learn it, so there are some difficulties present in the learning process.

D. Some Common Mistakes

The inference mechanism of AIML is to determine the corresponding model based on user input. When the user enters questions beginning with the word A, AIML uses A to compare with the content of the first-level nodes in the Graphmaster. The search proceeds in a depth-first sequence. When searching a branch of the graph fails to find a match, the search algorithm backtracks to the last node with unexplored branches and searches those.

The search sequence at each node is guided by the following sequence:

1. $word
2. #
3. _
4. word
5. <set>name</set>
6. ^
7. *

When reaching the end of the sentence matches the sentence, and the last node that contains the template matches the content, it means this pattern has been matched successfully. Then, the matching process can be terminated, and the inference mechanism will return to the node to remove the template content, which will be output to the user [2].

II. PROBLEMS AND SOLUTIOS CONCERNING AIML ON THE CHINESE TREATMENT

The robot based on the AIML language is an experience-based chat robot; therefore, the chatting results of the robot are related to a number of empirical knowledge systems. Knowledge repository entry, however, is difficult to enumerate; therefore, AIML-based robotic systems have joined certain rules. Additionally, the AIML language was originally designed for the Western language. Apparently, when dealing with Chinese architecture, full application is clearly infeasible; therefore, the language must be further adjusted to accommodate the characteristics of the Chinese language. The following will introduce this method from three aspects Chinese word segmentation, semantic expansion and context processing.

A. Chinese word segmentation

The AIML corpus uses words as the basic dealing unit. In Western languages, using space between words as a division sign is easy to handle. However, in Chinese, there is no obvious sign of division between words. Therefore, using AIML in Chinese must allow handling of Chinese word segmentation[4]. The function of Chinese word segmentation is to syncopate the characters used in Chinese sentences into several word sequences that carry different and certain meanings. Currently, there are three methods, which are based on a dictionary segmentation method, based on a statistical segmentation method and based on an understanding segmentation method. These three methods have their own advantages and disadvantages, so the current segmentation method of the AIML robot mostly uses a new method that combines different previous methods. In a word the principle technology that enables the Chinese intellectual chatting system can be exclusively attributed to segmentation technology.

B. AIML semantic expansion

The semantic competency of AIML language is relatively weak. If a question can be expressed in many ways that all have the same meaning, the corpus need to be enumerated for all questions. For example, there are many ways to ask the following question: "Where is the College of Information Science and Technology?" If all of the possible types of problems are enumerated, it would cause the corpus to become very large and slow. Therefore, it is very important to enrich the corpus that does semantic extensions for AIML language.

1) Sentence conversion

Making some changes that make full use of recursive jump marks and summing common sentences in common to achieve that body of knowledge can be separated from the form body of questions. Therefore, this approach can be more conducive to knowledge representation and collection. For example:

```
<category>
 <pattern>*[在哪里(where)|什么位置(position)|什么地方(place)]</pattern>
  <template>
   <think><set name=”search”>位置(place)</set></think>
    <srai><star/></star>
  </template>
</category>
<category>
 <pattern>* 的首都在(capital)[哪里(where)|什么位置(position)|什么地方(place)]
  </pattern>
  <template>
   <think><set name=”search”>首都位置(capital position)</set>
    </think>
    <srai><star></star>
  </template>
</category>
```

```
<category>
 <pattern>北京(Beijing)</pattern>
  <template>
   <condition>
    <li name=”search”value=”位置(postion)”>
    北京在中国的北部(Beijing is in the north of China).</li>
    <li name=”search” value=”所属国家(Country)”>
    北京是中国的首都，在中国(Beijing is the capital of China).</li>
    <li>北京是中国的首都，是中国的政治经济文化中心(Beijing is the capital of China  and the political economic and cultural center ).</li>
   </condition>
  </template>
</category>
```

The first two classifications can be seen as questions, and the following can be seen as a knowledge body of Beijing. In this way, this approach achieves a separation of questions and knowledge of the body. When the "United States" must join the knowledge, the questions of the United States do not need to re-list again. Similarly, the use of sentence transformation can also filtrate the option prefix and suffix of questions which are optional. Searching the core of the sentence in the knowledge tree makes the organization of knowledge seem more reasonable and reduces the difficulty of filling the corpus and dealing with the complexity of the corpus. If the methods of questions in certain areas have m types, then there are n bodies of knowledge according to the original method to write m*n items, but now only m + n species are required [3].

2) Merging similar problems

Expanding the AIML source code includes enclosing similar parts in brackets while separating each of the parts by vertical lines. When loading the knowledge base, restoring such patterning of all possible combinations of the sentence and loading each sentence is involved. Then. we can rewrite the above example as: 信息科学学院{的|在}{地址|位置}(position of the college of information and science). This makes it easier to enumerate all cases.

In the process of synonymous sentences, putting considerable semantic information into syntax description and using less phrasing expresses that more input statements can improve the generalization ability of language and greatly reduce the memory footprint of the knowledge base. For example: 信息科学学院的地址(position of the college of information and science), in the standard AIML, can be extended to other institutes such as “数学学院的地址(position of the school of mathematics)”,“心理学院的位置(position of the school of psychology)”. We will need to input different questions into the knowledge base, whereas for incoming semantic grammar, the problem can be expressed in the following form:

```
<category>
<pattern>  <set>academy</set>{ 的 | 在 }{ 地 址 | 位 置 }(position)</pattern>
<template><map name=”academy2location”><star/></map></template>
</category>
```

These methods can solve some of the semantic processing problems. However, we cannot enumerate all of the synonyms when writing the knowledge base, as this is unrealistic: this would lead to too many knowledge nodes in the tree, consume too much memory and lead to reduced processing rates. Because Chinese has many functional words, it is much more difficult to perform semantic processing.

3) Similarity Processing Mechanism

Similarity is a complicated concept that is widely discussed in the fields of Semantics, Philosophy and Information Theory. Calculations of lexical similarity occupy a significant place in each domain of natural language processing. It is also a key point in the case-based machine translation, automatic question answering, and multi document summarization systems. There are mainly two methods to do this calculation, based on the depth of lexical analysis.

a) TF-IDF Method based on the Vector Space Model

The TF-IDF Method, which is based on the Vector Space Model, belongs to statistical methods. According to the frequency of key words appearing in the knowledge base, it regards sentences as linear sequences of words not by analyzing the grammatical structure of sentences, but by using superficial information (such as the frequency and property of the words which compose the sentences) to measure the similarity of the corresponding sentences. Because there is no analysis of any lexical structure, this method cannot take the similarity of the overall lexical structure into consideration while calculating the lexical similarity [5].

However, the traditional TF-IDF Method cannot achieve the effects anticipated, for it cannot take the semantic meaning of words into account. For example, “cellphone” and “mobile phone” express the same meaning, which cannot be taken into consideration by the TF-IDF Method. Thus, this method has its restriction. Generally, the TF-IDF Method can be promoted. Semantic meaning will be added into the composition of Vector Space elements of TF-IDF to eliminate the appearances of synonym and polysomic. To distinguish between synonym and polysomic, such methods as building semantic trees, or semantic nets, such as Word2net and Howmet, can be adopted.

b) Semantic Analysis of statement

This is a deep structural analysis method, comparing two sentences deep in syntactic analysis and combining sentence semantic similarity calculation. Semantic similarity calculation requires semantic knowledge-based resources. There are studies on the robot ALICE’s reasoning mechanism, which has been improved: using Dong zhenhua and Dong qiang’s Hornet source in the reasoning process of the robot allowed the robot to handle an added word similarity scoring mechanism [3][6]. When two words are compared, it can calculate the similarity between them; if the similarity exceeds a threshold value (for example, greater than 0.9), it considers that they match and continues to compare the rest. When below this threshold, then it tries to filter the

words in the sentence and continue the matching process. In this method, we assign different weights to match keywords, synonyms, and wildcard, and give a certain score for the composition of the filter. When receiving a question, remove all possible knowledge tree equivalent models. According to the right question, when pattern matching with the value obtained by deducting the sum of questions, ignore part of the estimated fraction of merit evaluation criteria and select the best template as the final result. The weight of each part needs to be different in different matching adjustments to achieve the best results. This approach may reduce system speed and accuracy, but it can reduce workload that is expanded knowledge base.

c) Sentence similarity computing based on dependency relations

The key point of this type of calculation is how to obtain the information of dependency relations between different components of sentences. The analyses of dependency relations, which is made up by the laboratory of computer scientific technology, and the intelligent content management of Harbin Institute of Technology can reach more than 86 percent accuracy [5].

In the knowledge base, the dependency tree is a type of complex nonlinear relationship. It can be very costly if we try to find the exact match for the whole dependency tree. Moreover, people tend to ignore the modifier components in Chinese and so understanding the sentence depends only on some key parts. While the relevant key words in Chinese can be modified by different components, it will cause many more difficulties if we place emphasis on these modifiers. Therefore, when we calculate the similarity based on dependency relations, we only consider the similarity between those effective matching pairs, which includes key words of the sentence, and the matching pairs depend directly on their effective phrases. The formula for similarity calculation is as follows:

$$s'(A,B) = \frac{\sum_{i=1}^{n} W_i}{MAX\{PairCount1, PairCount2\}} \qquad (1)$$

In this formula, $\sum_{i=1}^{n} W_i$ stands for the total weight of effective matching pairs in sentence one and two. Paircount1 is the number of effective matching pairs in sentence one, while paircount2 works the same.

The definition of weight of matching pairs is: assume there are two matching pairs AB and CD (each one of ABCD is a word). If a=c and b=d, then the weight of matching pairs AB is 1 and that of CD is also 1. If A≠C but b=d or a=c but B≠D, then the weight is 0.5. Else the weight is 0.

C. AIML Context Reasoning

A chat robot named ALICE, based on the AIML language, has a certain context reasoning ability. In the conversation, it can record the previous sentence of output and match with the part of <that>, then discern whether it is just talking to the topic, to make the right response. This method enables the robot's answer to not be too stiff to some degree, but a large portion of the hidden information in the dialogue will be ignored. At present, several studies propose a new method based on the original robot for AIML to improve:

1) CNLIS system [7]

The CNLIS system includes importers and processors, an organized method of knowledge, a pattern search and answers to extract. Using the moving window technique always keeps the most recent eight dialogues and accords the information processing problems anaphora and restores the default component, to further enhance the computer's comprehension ability. For example, the following three questions:

1.什么是 C 语言？(What is c language?)

2. C++呢？(About c plus plus?)

3. 它有什么特点？(What's special about it)

A question matches in a normal analysis, if that fails, CNLIS will try to perform the default context reduction treatment and make understanding ellipsis match with no default complete sentences. For example, restoring sentence 2: according to the syntactic and semantic analysis, "C++" has the same component with "the C language". Semantically, they are the same computer language. The modal particle will have little impact on the sentence, so the sentence can be reduced to "什么是 C++？(What is C plus plus)". For example, restoring sentence 3: According to the previous sentence "什么是 C++？(What is C plus plus)", we know the centre launched its word "C++", so we can replace "它"(it) with "C++", then the sentence can be reduced to "C++有什么特点？(What's special about C plus plus)". In this way, CNLIS will enhance the supposing reasoning ability of the robot, and make the answer of the robot based on AIML language more flexible.

2) Ontology knowledge base [1]

The AIML robot is a chat robot based on experience; you must provide considerable experience knowledge to build a large enough knowledge base. At present, in terms of natural language matching and understanding context, the robot has significant advantages. However, in terms of semantic understanding and logical reasoning, especially in some areas of expertise [1], the robot based on the experience of stimulus-response reasoning mechanism has larger defects. Therefore, we need to build a new reasoning knowledge base to cope with all questions associated with a particular expertise in semantic reasoning, and feedback reasoning final results. The rapid development of ontology and semantic web technology provides a new solution to solve the problem of AIML robot intelligent reasoning [8].

Ontology can be considered semantically rich metadata: it is a collection of specific information in the field of concepts and relationships between concepts composed [9]. It is mainly used to

construct the conceptual level models and knowledge sharing. The ontology knowledge base is a collection of instances in the field of ontological language, an information organizational framework of semantic reasoning, and the collecting and extracting of resources and information retrieval based on the original object metadata information [10]. Using the semantic reasoning interface of semantic web ontology and based on AIML, the robot combines design solutions that can support semantic reasoning based on natural language and has a very high satisfaction rate [11].

III. THE APPLICATION OF THE AIML

At present, the AIML application in the direction of the Chinese language is still in its infancy, but the dialogue system based on the ALICE robot has been improved and widely used.

A. The campus system

(1) Through the improvement of ALICE, a robot based on expression of intelligent campus counselling is provided for the majority of teachers and students. To use effects better, the system knowledge base is established to match the priority [12].

(2) Based on the student model and on categorizing the student model, according to the student's learning style, the robot can provide different responses. This model use the courseware conforming to the SCORM standard to form their own set of established standards and formats and mining the knowledge form of the SCORM courseware to realize the automatic update of AIML knowledge base[13].

(3) The graduate admissions system embedded in ALICE uses a Chinese word segmentation module that has developed a set of intelligent customer service system based on B/S to realize the user interactions with the robot by using JAVA EE technology. After testing, the system was launched in October 2012 and used in graduate students' work [14].

(4) Based on the AIML language, building an individualized English learning companion, using the data mining method to detect the user's level of intelligence, monitoring the progress of learning and using natural language to dialogue with him, provides a personalized learning environment for learners [15].

(5) The FAQBot has been designed to provide consulting services for undergraduates. The bot accepts the input of natural language from the user and then navigate answers in natural language through the information base. Three experimental systems have been constructed (one is a pure natural language dialogue system, one is a related domain knowledge system and one is a combination of a dialogue and knowledge system). Therefore, without any increase in code, the database can be easily modified and focused on a particular topic [16].

(6) Multi-agent systems and AIML are used to improve learning in a virtual environment between teachers and students. Teachers can obtain more information from students to guide the students' learning and progress and students can obtain timely feedback from the teachers [17].

(7) Building a system that can automatically give accurate and anthropomorphic solutions for the students' questions in real-time in distributed e-learning environment based on Web. Using the Chinese word segmentation, latent semantic analysis, semantic matching and TTS technology to give the structure design and function realization of automatic question answering system based on the structure of browser, Web server and database server three-layer application model [18].

B. The library system

(1) Based on the ALICE intelligent robot, having word segmentation and index searching on the Chinese knowledge base of the robot, using the similarity calculation and getting the highest similarity knowledge questions to ratiocinate to realize the application of robot in the library advisory [4].

(2) Based on the ALICE intelligent robot, Tsinghua University has developed the library advisory robot "Xiao Tu" to provide picture book searching, reference consultation, learning by oneself and other services. Due to the reasoning mechanism, the robot can answer almost all the problems. At present, the web version and application version have been made for readers [19].

C. E-commerce

(1) The electronic commerce recommendation system based on AIML, first by building user model, generates the corresponding products recommended list for particular users to realize first time recommendation. After several natural language interactions with users, the system can find the users' interests and correct the suggestion list for the first time [20].

(2) Aiming at the practical problem that a customer cannot negotiate with merchants in real-time and online in the process of e-commerce order treating, on the basis of ALICE, using JAVA, Program D, AIML technology, database technology, knowledge engineer, inference rules and inference strategy have realized the man-machine dialogue software robot for e-commerce order treating in real-time. This has widened the application range of the ALICE chat robot and provided a new tool for e-commerce order real-time online consultation and negotiation [21].

D. Mobile platform using

At present, the AILM language has been used for mobile phone platforms and to develop the applications that are good for life.

(1) A query software system for pregnant women health knowledge, based on the Android smartphone platform, uses the ALICE robot Q&A system framework, speech recognition technology from the Sphinx platform and the relevant technology of the distributed system based on the Android platform. This system also designs such modules as the user interface module, feature extraction module, client/server communication module, the speech recognition module, and intelligent robot Q&A module [22].

(2) Using QR codes for mobile learning and collaborative learning research of special situations in AIML, which produce a system for learning situation. On mobile devices (such as smartphones and tablets) using natural language to ask a question and link to a particular interpreter with QR tags. With the help of these tools, the learners can interact with the virtual world through a virtual tutor to increase their learning experience.

Using this technology, students can do situated learning and make self-learning and collaborative learning more efficient and virtual [23].

IV. CONCLUSIONS

The Turing test has proposed that if a computer can pass this test, the computer has the thought process of a person [24]. However, at present, computer science is still far from achieving this goal. The robot based on the AIML language cannot at present answer various questions freely, similar to humans. Robots depend on their own knowledge base and do not have reasoning or understanding abilities. However, now that there are more and more AIML robots, the robot based on the AIML language may have a breakthrough development in the near future.

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