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THE METHOD OF NATURAL LANGUAGE UNDERSTANDING BASED ON MARCHINE LEARNING IN MOBILE GIS

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ABSTRACT

Human-machine interaction between natural language and GIS is an intellectualized expression of mobile GIS, which process is that extracting the syntax structure of natural language, and then translating it into the corresponding GIS instruction. However, it is not perfect that the summarized sentence patterns and its corresponding instruction in current research results and achievements. Consequently, according to existing sentence pattern library and instruction library, this paper uses Artificial Neural Network Algorithm (ANNA) based on Genetic Algorithm (GA) to rearrange existing knowledge structure which combined with machine learning methods, for the purpose of improvement the sentence pattern library and instruction library constantly, and eliminating the semantic barriers existing between unstructured spatial information in natural language and structured spatial information in GIS, then realize the human-machine interaction between users and GIS more naturally. The experiment shows that this paper can identify effectively the correct GIS instruction which corresponding the no-summarized sentence.

Keywords: *Mobile GIS, Natural Language, Machine Learning, Artificial Neural Network Algorithm (ANNA), Genetic Algorithm (GA)*

1. INTRODUCTION

When mobile intelligent era coming with the popularity of smart phones and the rapid development of mobile internet, mobile GIS which is one of the mainstream directions of GIS applied research, should accelerate the development of intellectualization. In view of the screen size and computing power of mobile intelligent terminals, intelligent interactive mode combines with voice technique could make a better communication between user and mobile GIS terminals. At the same time; this method can avoid “eye busy” or “hand busy” in using application process when users are moving or walking.

For the reason of semantics obstacle between unstructured spatial information in natural language and GIS structured spatial information, we need to handle user’s natural language processing (voice instructions) [1].

In this way, we can make the interactive process natural and fluent. Therefore, natural language understanding (NLU) has become the keystone and difficulty in the research field of Mobile GIS.

The aim of natural language understanding in mobile GIS is that mobile intelligent terminals transform the user’s natural language into executable and recognizable GIS space operations on mobile terminals. However, the conversion rules of natural language and GIS commands are not perfect in the current study. Therefore, we used machine learning (ML) method into natural language understanding in this paper, which could simulate human learning behavior, and reorganize and perfect the existing research achievements. And this method can recognize the new voice instructions and maximize the satisfaction of user’s position service needs.

2. CORRELATION RESEARCH

2.1 Natural Language Understanding

Natural language understanding is a significant research direction in the field of artificial intelligence, which is an important bridge for human-computer interaction in natural language. The intelligence level of mobile GIS depends on the degree of natural language understanding.

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In recent years, the research on natural language understanding has made a series of achievements: Based on Chinese, GIS query language use statistical modeling method and pattern matching technique to extract spatial information from text sentences (Zhou Yankun, Li Manchun) [2]. A thinking method that mainly uses the keywords of natural language to structure a model library for mapping the query sentences under the conditions of a limited applied range (Zhang Lianpeng) [3]. Spatial information query method, which is based on restricted natural language in a mobile environment, comes up with a set of method of formal processing query language, and gave a prototype implementation (Ma Linbing) [4]. Yang Dongqing et al. Proposed a query method of restricted Chinese language based on E-R model [5]. Xu Aiping researched GIS query language in Chinese, and she proposed an intermediate language way of semantic query trees, designed a set of conversion algorithm to achieve the conversion of GIS query language in Chinese into SQL statements [6]. Han Yi proposes an improved algorithm by am ending the nonlinear relationship to im prove the accuracy of high MFCCs which are the complementary features to low MFCCs for emotion speech recognition [7]. Long Yi et al. Proposed an analytic method of GIS command based on restricted natural language, and their classification marked the restricted natural language, and designed corresponding GIS command functions to realize the geographic information service intelligently [8].

There is a series of achievements in the field of natural language understanding at present, but problems still remain:

(1) The conversion method of natural language into GIS command is not uniform.

(2) Due to the limitation of artificial summary, the sentence pattern library and the GIS command library should be a further expansion.

Therefore, this article chooses the method of machine learning to simulate the human learning behavior, and rearrange the exits sentential pattern structures, in order to obtain new sentential pattern structures and corresponding GIS commands of spatial operation.

2.2 Machine Learning

Machine Learning is the core of artificial intelligence. In recent years, theory of Machine Learning, which has a successful application and development in many application fields, has become one of the foundations and the hotspots of Computer Science. Its main application fields include the following aspects: expert system, automated reasoning, natural language understanding, pattern recognition, computer vision and intelligent robots, etc.

At present, the research situation of machine learning is mainly concentrated in the following aspects: the research and application of intelligent cars, the classification of things and objects, stock prediction, protein function and structure prediction, genetic sequencing techniques, etc. The research and application of intelligent cars are making intelligent cars accomplish operations, such as turn left, turn right, go forward or parking, on a simulation road by learning the meanings of some traffic signs. The classification of things and objects is that make computers to study the characteristics that is extracted from things and objects, and to classify the unknown things, such as text classification and image classification, etc. [9].

In the field of natural language understanding, the main source of Machine Learning is primitive linguistic data. We should preprocess the linguistic data through word segmentation and text markup firstly. Then learn the existing text samples, training and analysis, applied to the unknown text, try to learn the meaning of the unknown text to solve practical problems.

In a word, Machine Learning is an important way and the key method of mobile GIS intelligence. The study of Machine Learning methods in the field of natural language understanding will promote the further development of natural language understanding and mobile GIS intelligence.

3. MGA-BP ALGORITHM

The natural language understanding in mobile GIS means that mobile intelligent terminals transform the user's voice commands into text language, extract the syntactic structure, and then get corresponding GIS operation commands through comparison with the GIS rule commands library. But there are some limitations in current research, for natural language syntactic structures in mobile GIS are artificially summarized. So, in order to achieve the purpose of recognizing new cognitive syntactic structures, we used artificial neural network BP algorithm to study and train existing syntactic structures in this paper. Meanwhile, in view of the weakness of time–consuming training of BP algorithm, we use Genetic Algorithm to be an aided optimization of the BP algorithm in this paper, which could improve the rate of learning and

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training. And optimized algorithm could recognize new cognitive syntactic structures faster.

3.1 An analysis of natural language text

The artificial neural network could bind to a given learning sample to adjust the interconnection weights between neurons by faster speed and higher accuracy, and make the system reach a stable state to content the learning requirements. Back Propagation Algorithm (BP algorithm), whose purpose is that calculating the model parameters (weights) according to the actual input and output data.

This paper analyzes natural language text to construct a suitable network structure for BP algorithm. And this is my paper's research focus. The network structure of my paper is established as follows:

(1) To classified mark the vocabulary of GIS command with numbers [8].

(2) To identify the user's voice commands, and convert these commands into text formats. Then to use the ICTCLAS segmentation algorithm which is developed by Chinese Academy of Sciences to realize words segment and part-of-speech tagging. Finally to extract the syntactic structure of sentences after removes the interference words.

(3) To digital mark the extracted syntactic structures.

(4) To digital mark the GIS commands.

(5) To extract the numbers of syntactic structures and to form a three-layer BP neural network structure. There are 10 training samples, i.e. There are 10 input and output pairs (I_p, D_p), p=1… 10, wherein the input vector is $I_p = (i_{p1},...,i_{pm})^T$, actual output vector is $D_p = (d_{p1},...,d_{pn})^T$, and theoretical output vector is $O_p = (o_{p1},...,o_{pn})^T$. To combine these vectors with mobile GIS, the input vector is a matrix getting through textual analysis of the user's voice commands. The output vector is a matrix getting through digital mark the corresponding GIS commands.

Input training sample:

$$\begin{pmatrix} 320 & 112 & 0 & 0 \\ 111 & 0 & 0 & 0 \\ 120 & 0 & 0 & 0 \\ 130 & 0 & 0 & 0 \\ 151 & 152 & 0 & 0 \\ 140 & 1 & 0 & 0 \\ 140 & 1 & 2 & 3 \\ 140 & 1 & 2 & 4 \\ 140 & 310 & 0 & 0 \\ 140 & 310 & 310 & 0 \end{pmatrix}$$

Output training sample:

$$\begin{pmatrix} 140 & 0 & 0 & 0 \\ 130 & 150 & 0 & 0 \\ 100 & 110 & 120 & 0 \\ 270 & 0 & 0 & 0 \\ 240 & 0 & 0 & 0 \\ 250 & 0 & 0 & 0 \\ 260 & 0 & 0 & 0 \\ 170 & 0 & 0 & 0 \\ 190 & 0 & 0 & 0 \\ 190 & 0 & 0 & 0 \end{pmatrix}$$

3.2 The optimization of the weight coefficient

BP algorithm has the following shortcomings: (1) The optimum value is local optimum, but not global optimum. (2) Training time is too long. (3) It needs time and energy to determine the appropriate model, algorithm and parameter settings. However GA has a better global search performance. Hence we use GA to optimize and improve the weights coefficients of the BP neural network, for the purpose of enhancing the speed of learning and training text, ameliorating performance of the BP neural network, and adding up some certain practicality of BP algorithm.

The optimization settings are as follows:

(1) The population initialization process. This paper has built a three-layer BP neural network which contains an input layer node number (it's 4), hidden layer node number (it's 8), output layer node number (it's 4). And I use real-coded schema to avoid situations of lack of precision.

(2) The definition of fitness function:

$$F_i = \frac{1}{\sum_{i=1}^{n} (D_i - O_i)^2} \quad (1)$$

Wherein, O and D are the expected output vector and the actual output vector; n is the number of iterations.

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(3) The selection of crossover probability and mutation probability. The crossover probability controlled the frequency of crossover operation; the overlarge probability would result in a large generation gap while the insufficient one will cause the algorithm into a dull state [10]. Generally the probability would be limited among 0.25 and 1. I choose 0.6 in this paper. The mutation probability can maintain the diversity of population, and has the ability of local search at the same time; it also may repair the important genes lost in the cross process. The overlarge probability would lead to the algorithm tend to random searches, while the smaller one will lead to the algorithm fall into the local minimum value. Generally it would be chose among 0.001 and 0.1. I choose 0.01 in this paper.

(4) Population size, in other words, the total numbers of chromosomes. The oversized population would lead to a longer running of operation, while the undersized would be unfavorable to the evolution. Take this factor into consideration; population size is always between 20 and 100. I choose 40 as the sample size in this paper.

4. EXPERIMENT AND ANALYSIS

This paper applies the BP algorithm based on Genetic Algorithm in the field of mobile GIS by learning the existing sentences samples, for the purpose of recognizing the GIS commands corresponding to unrecognized sentence patterns.

(1) The experimental environment

Because the algorithm in this paper should be used in mobile GIS, the experimental environment is a mobile intelligent terminal based on Android OS. The parameters are as follows:

Table 1: Mobile Phone Parameters

Mobile phone model number	HTC G11
OS	Android OS 4.0
CPU frequency	1024MHz
RAM capacity	768MB
ROM capacity	1.1GB

(2) The experimental conclusion

Fig.1. The Effect Of Voice Navigation

Input the query sentence "from the Chong Qing University of Posts and Telecommunications to Jiefangbei" by voice, and the mobile intelligent terminal could give corresponding navigation route. The experiment shows that the method of this paper could achieve the purpose of recognizing voice commands and giving the navigation route through study the existing text data.

(3) The contrast of performance

We use Genetic Algorithm to be an aided optimization of BP algorithm, which could improve the rate of learning and training. The effects are shown below:

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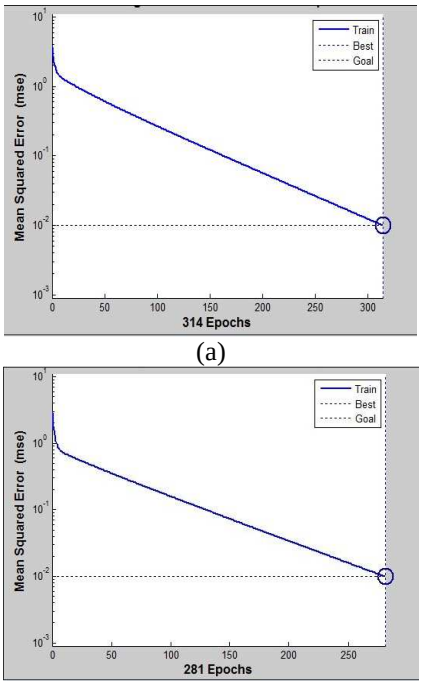

Fig.2. The Figure Of Experimental Effect Contrast

Fig(a) shows that using BP algorithm to get the optimal value of the weights, the time complexity is 5s, and the number of iterations is 314 times; and Fig(b) shows that using BP algorithm based on GA to get the optimal value of the weights, time complexity is 3'46", and the number of iterations is 281 times; Hence, it is that using GA auxiliary BP algorithm to optimize the weight coefficient; it could effectively reduce the time complexity and iterations, and improve the rate of learning and training.

5. CONCLUSIONS

In this paper, combined the method of machine learning, we have a preliminary study of the method of natural language understanding in the field of Mobile GIS. The conclusion is that the method of natural language understanding based on machine learning, to some extent, could recognize the GIS commands corresponding to unrecognized sentence patterns. We use Genetic Algorithm to be an aided optimization of BP algorithm, which could improve the rate of learning and training. However, due to the limitation of sample data, the recognition accuracy of GA-BP algorithm should still be improved. Moreover it is well worth to a further study that the intelligent method of natural language understanding in the field of Mobile GIS.

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