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Optimisation of regional higher education resources search method based on attribute description matching

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Abstract: To overcome the problems of long search time and low search accuracy of traditional search methods, a search optimisation method of regional higher education resources based on attribute description matching is proposed in this paper. Firstly, the language model of regional higher education resources is established, and the word relevance is calculated according to the position of each word item. Secondly, the phased screening method is used to construct the search model of teaching resources. Then, the matching degree of regional higher teaching resources is calculated. Finally, the attributes of teaching resources are labelled according to the attribute description to optimise the search method of teaching resources. The results show that when the amount of data is 800 TB, the search accuracy of this method can reach 92.3% and the search time is only 11.0 s. This shows that the proposed method can improve the search accuracy and efficiency.

Keywords: attribute description matching; regional higher education; resource search; phased screening.

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1 Introduction

Rich network teaching resources provide a wide choice space for sharing. At the same time, due to the openness of the network, the teaching resources in the network have the characteristics of wide variety and great quality difference, which also causes some difficulties in the search of resources in the teaching process. Therefore, how to effectively locate high-quality network teaching resources and how to reduce the search cost of network teaching resources are the problems to be solved in the process of network teaching resources search. With the innovation of information technology and

the emergence of teaching model reform, higher education has diversified and developed on a large scale, and higher education resources have increased linearly (Jiang, 2018). The acquisition method of educational resources is no longer the traditional university classroom and school library, but the acquisition of higher education resources through space and region and in the form of network coverage (Huang, 2019). Under the condition of regional open development, higher teaching resources grow explosively, with many kinds and serious dispersion of teaching resources, such as network teaching courseware, teaching materials, teaching topics and other resources, which makes it more difficult for users to search these resources and reduces the utilisation rate of regional higher teaching resources (Azarbonyad et al., 2019). How to search regional higher education resources quickly and accurately is an urgent problem to be solved (Thirugnanasambandam et al., 2021).Therefore, a search method of regional higher teaching resources has entered the vision of scholars.

Shao (2019) proposes a dynamic search method for regional higher education resources based on classification and evaluation algorithm. Firstly, the collection module, data classification module and resource search module are designed to obtain regional higher education resources through the collection module. Through the data classification module, the collected regional higher education resources are classified by classification search tree. According to the classification results, the regional higher education resources are searched through the resource search module. Finally, the practical application performance of this method is verified by simulation experiments. An et al. (2018) proposed the vertical search method of regional higher education resources based on the full-text retrieval toolkit Lucene, constructed the overall framework of regional higher education resources vertical search, and designed the teaching resources index module and search module. According to the search process, the full-text retrieval toolkit Lucene was used to realise the vertical search of regional higher education resources through the search module. However, the dynamic search time of regional higher education resources by the above two methods is long, resulting in low search efficiency. Wang et al. (2018) proposed a search method for regional higher education resources based on word vector expansion. Firstly, text mining technology is used to mine regional higher education resources, and the mined regional higher education resources are preprocessed combined with natural language processing method. According to the preprocessing results, a search model for regional higher education resources is constructed through word vector expansion. Yu et al. (2018) proposed an ontology-based search method for regional higher teaching resources. Firstly, regional higher teaching resources are obtained, and then the obtained regional higher teaching resources are queried and expanded by using the semantic concept of ontology. According to the expanded query results, a regional higher teaching resource search model is constructed. However, the search accuracy of regional higher teaching resources by the above two methods is low, resulting in poor search effect of regional higher teaching resources.

Attribute is the embodiment of people's collective wisdom. It is different from keywords. It is not only limited to the data in the resource database, but also people's summary of the content of the resource database and some words summarised, which is more in line with people's subjective intention. If an attribute is marked with the same educational resource data by many people, it shows that this attribute can better represent the content expressed by educational resource data. If two educational resource data are marked with the same attribute, the two educational resource data may be similar. The more times they are marked, the higher the similarity. Aiming at the problems of low

resource search accuracy and poor search effect of higher teaching resources in the above methods, this paper introduces the attribute description matching method to optimise the search method of regional higher teaching resources. It can improve the search effect of regional higher teaching resources. The specific research route of this method is as follows:

Firstly, the language model of regional higher education resources is constructed to obtain the position of each word item in the document, and on this basis, the correlation between word semantics and words in the subject classification tree is calculated.

Secondly, using the method of attribute description, this paper constructs the classification model of regional higher teaching resources, divides the regional higher teaching resources into five categories: value, availability, diversity, creativity and substitutability, matches the classified teaching resources, and calculates the matching degree of regional higher teaching resources.

Then, the attributes of teaching resources are labelled according to the attribute description, and the search method of regional higher teaching resources is optimised according to the attribute description matching.

Finally, the effectiveness of this method is verified by two indexes: teaching resource search accuracy and teaching resource search time.

2 Calculation of word correlation of regional higher teaching resources

2.1 Construction of language model of regional higher teaching resources

The new language model of regional higher education resources has the following characteristics:

First, large-scale sharing: there are many people sharing courses. Tens of thousands of people can share a course at the same time. Second, sharing openness: free and open to users, no one needs to pay for any courses; there is no entry threshold for learners; without geographical restrictions, it has truly realised that science has no borders and achieved a sharing degree that can not be achieved by other sharing modes. Third, shared network: anyone can learn a teacher's course anytime and anywhere, communicate with 'classmates' and teachers all over the world, listen to different views, and is no longer limited to one-way 'indoctrination' in the classroom.

Before constructing the language model of teaching resources, firstly, the total number of communication in words should be calculated (Zhou et al., 2019). Suppose that $k(i, j)$ represents the number of word items spreading from position j to position i, and $c'(w, i)$ represents the total number of word items spreading from position i to position w, which is expressed by the formula:

$$c'(w, i) = \sum_{j=1}^{N} c(w, j) \times k(i, j) \tag{1}$$

where i, j represents the position of each word item, N represents the position of all word items, and $c(w, j)$ represents the number of occurrences of word items at position i (Chi et al., 2019).

Therefore, even if $c(w, i)$ is 0, the total number of propagation $c'(w, i)$ must be greater than 0. After propagation, the counts of word items $q1$ and $q2$ in position i are greater than 0. The word frequency vector $\langle c'(w_1, i), \ldots, c'(w_N, i)\rangle$ is obtained according to the

total number of propagation in the word item (Hu et al., 2018). Set D_i as the virtual document at position i, build the regional higher education resource language model of the virtual document at position i, and obtain the position of each word item in the document:

$$p(w|D,i)=\frac{c'(w,i)}{\sum w'\in vc'(w',i)} \tag{2}$$

In the formula, v represents the whole vocabulary set and $p(w|D, i)$ represents the location language model at position i.

2.2 Calculation of word relevance of higher teaching resources

In order to realise the accurate search of regional higher education resources, it is necessary to calculate the word relevance according to the position of each word item in the document (Diallo et al., 2019).

1 Correlation degree in subject classification tree

In this paper, according to the path length between the two word nodes, the correlation degree of the two words in the discipline classification tree is calculated through the node distance (Boukhari and Omri, 2020). Assuming that the two words are represented by W_1, W_2 respectively, and the length of the path between the two nodes in the discipline classification tree is $Sim(W_1, W_2)$, the expression of the correlation degree $Sim(W_1, W_2)$ of W_1, W_2 in the discipline classification tree is:

$$Sim(W_1,W_2)=\alpha/(dt+\alpha)p(w|D,i) \tag{3}$$

where α represents the distance parameter. Since the above formula only considers the length of the path between the nodes of two words W_1, W_2 in the discipline classification tree, and does not consider the depth of W_1, W_2 in the discipline classification tree, when W_1, W_2 is at the same distance (Madni et al., 2018), W_1, W_2 is closer and closer to the root of the classification tree, resulting in the smaller and smaller correlation of W_1, W_2 in the discipline classification tree, the above formula needs to be improved:

$$Sim(Wt_1,Wt_2)=\alpha\Big/\left[d-\frac{t_1+t_2}{2}+\alpha\right] \tag{4}$$

In the formula, t_1, t_2 represents the depth of W_1, W_2 in the subject classification tree (Abdullah and Kumar, 2018).

2 The semantic relevance of words

Set S_{11}, S_{12}, …, S_{1n} to be n concepts in W_1 and S_{21}, S_{22}, …, S_{2m} to m concepts in W_2. According to the concepts in W_1, W_2, calculate the maximum correlation between W_1, W_2, the calculation formula is:

$$Sim(W_1,W_2)=\max Sim(S_{1i},S_{2j}) \tag{5}$$

Set the path distance of two semantic P_1, P_2 as dp, then the expression of the semantic relevance of words is (Li et al., 2021; Grévisse et al., 2020):

$$Sim(P_1, P_2) = \beta/(\mathrm{dp} + \beta) \tag{6}$$

In the formula, β represents the distance parameter.

3 Relevance of words

According to the relevance results obtained above, the relevance of words is calculated, and the expression is:

$$Sim(W_1, W_2) = \left[\frac{\alpha}{\left[d - \frac{t_1 + t_2}{2} + \alpha \right]} + \beta/(\mathrm{dp} + \beta) \right] \Big/ 2 \tag{7}$$

Calculate the relevance of two words in the subject classification tree and the weight of the semantic relevance of the words (Chen and Liang, 2020):

$$Sim(W_1, W_2) = \frac{\alpha}{d - \frac{t_1 + t_2}{2} + \alpha} \times \gamma_1 + (\beta/(dp + \beta)) \times \gamma_2 \tag{8}$$

In the formula, γ_1, γ_2 respectively represents the relevance weight coefficient of the two words in the subject classification tree and the relevance weight coefficient of the word semantics.

This paper comprehensively calculates the word correlation of higher teaching resources through the correlation degree in the discipline classification tree, the correlation degree of word semantics and the correlation degree of words. Through this result, it lays a data foundation for the matching of regional higher teaching resources and further realises the matching of regional higher teaching resources.

3 Search optimisation of regional higher education resources based on attribute description matching

3.1 Construction of search model for regional higher education resources

According to the matching degree of the regional higher teaching resources described by the above-mentioned calculated attributes, referring to the characteristics of the character data, the search model of the regional higher teaching resources is constructed and constructed by the method of staged screening. It is known that the occurrence probability of data *A* in ordinary text may be greater than the occurrence probability of data *B*. Therefore, after the index is generated, the operation is hidden according to the frequency of region division, the character value is mapped to the corresponding bucket number, and then the order of all bucket numbers is straightened, extract the frequency information features of hidden characters (Yang, 2019).

Let each of the letters represent different character data, enter the letter frequency and the number of buckets in Table 1 in the first step of verification, and calculate the frequency value that each bucket can hold. The formula is:

$$r = \frac{1}{n}(1 \pm 10\%) match_{BARM}(Qw_i, Pw_i) \tag{9}$$

In the formula, n represents the number of buckets; 1 ± 10% represents the floating range where the same character is split into different buckets in the subsequent allocation process (Zhang et al., 2019). The second step needs to ensure that there is a corresponding mapping relationship between characters and bucket numbers according to the following restrictions: first, assign characters to each bucket in order until the end of the assignment; second, when the remaining space in the bucket cannot be put down When a character with the highest frequency is used, it proves that the bucket can end the assignment task and start the assignment to the next bucket. The third step is to use the hash function to capture the random value of the bucket number. The verification execution process of the function is controlled by the following formula:

$$hash(*) = s\varphi keymod1(0,1) \tag{10}$$

In the formula, s represents the size of the hash table; $hash(*)$represents the downward rounding of the expression by the multiplicative hash function, and the value range of the parameter φ is (0, 1); $\varphi keymod1$ represents the decimal part of the numerical product of the value product in the (0, 1) interval that is multiplied by key. In order to have a matching relationship between the verification method and the encryption method, the default parameter φ = 0.618, through the above calculation and analysis process, establishes a regional higher education resource search model, and outputs the search results. The expression is:

$$E = (\gamma_1 + \gamma_2)\frac{COV(a,b)}{Bhash(*)} \tag{11}$$

In order to improve the data search effect of regional higher teaching resources search, the higher teaching resources are classified into grids according to certain attribute rules, and the abstract teaching resources data search problem is transformed into a path optimisation problem in the grid. At this time, the engineering problem is transformed into a mathematical optimisation problem, which can improve the data search effect of teaching resources.

3.2 Calculation of matching degree of regional higher teaching resources

According to the search model of higher teaching resources obtained in the previous section, the classification model of regional higher teaching resources is constructed by using the method of attribute description, and the attributes of regional higher teaching resources are divided into five categories: value, availability, diversity, creativity and substitutability.

Based on this, the expression of constructing the classification model of regional higher teaching resources based on attribute description is

$$R = \{R_{value}, R_{available}, R_{variety}, R_{create}, R_{substitute}\} \tag{12}$$

In the formula, R represents the regional higher teaching resources; R_{vaue} represents the value of teaching resources, which is used to describe the values of regional higher education, mainly including the teaching effect, the overall development of the student body, etc.; $R_{available}$ represents the availability of teaching resources, with In describing the availability of online learning resources in higher education, it can improve the teaching

effectiveness of course network resources; $R_{variety}$ represents the diversity of teaching resources, which refers to rich teaching resources, and teaching diversity can be an important means to improve the effect of higher education; R_{create} means that the teaching resources can be creative, which refers to the cultivation of students' creative thinking in the teaching process; $R_{substitute}$ means the substitutability of teaching resources, which refers to the replacement of traditional teaching through online teaching.

According to the classification results of the acquired teaching resources, the regional higher teaching resources are matched to obtain the resource matching degree. Construct the smallest common set LCS(C_q, C_p) showing the attribute concept C_q, C_p, and its expression is:

$$\mathrm{LCS}\left(C_q, C_p\right) = \left|C_q \cap C_p\right| \tag{13}$$

$$sim_{attribute}\left(Qw_i, Pw_i\right) = 2\frac{LCS\left(C_q, C_p\right)}{\left|C_q\right| \cup \left|C_p\right|} \tag{14}$$

In the formula, Qw_i, Pw_i represents resource description information, and $|C_q|$, $|C_p|$ represents a collection of Qw_i, Pw_i attribute concepts.

In summary, the matching degree of regional higher teaching resources based on attribute description is:

$$match_{BARM} = \left(Qw_i, Pw_i\right) = \frac{sim_{attribute}\left(Qw_i, Pw_i\right)}{Sim\left(W_1, W_2\right)} \tag{15}$$

According to the above formula, the matching degree results of regional higher teaching resources are obtained, and the search model of regional higher teaching resources is further optimised by using attribute matching, so as to improve the search efficiency of regional higher teaching resources.

3.3 Attribute labelling and search optimisation of regional higher education resources

For ease of analysis, this paper lists an example, as shown in Figure 1. In this figure, educational resource data p_1 is similar to educational resource data p_2, and their contents are related to query word q_1. Query word q_1 is not included in educational resource data p_1, and query word q_1 is included in web page p_2. When users use query word q_1 to find educational resource data, using the traditional method, the search result is only educational resource data p_2, but the more qualified educational resource data p_1 is filtered out.

Therefore, the similarity formula between education resource data can be defined as follows:

$$Sim\left(p_i, p_j\right) = \sum_{m=1}^{n} \frac{T_m\left(p_i, p_j\right)}{T_m\left(p_i\right) + T_m\left(p_j\right) - T_m\left(p_i, p_j\right)} \tag{16}$$

where $T_m(p_i)$ represents the number of times the m label labels educational resource data p_i, $T_m(p_j)$ represents the number of times the m label labels educational resource data p_j, and $T_m(p_i, p_j)$ represents the number of times the m label labels educational resource data p_i and educational resource data p_j at the same time.

Figure 1 Relationship between query words and educational resource data of traditional methods

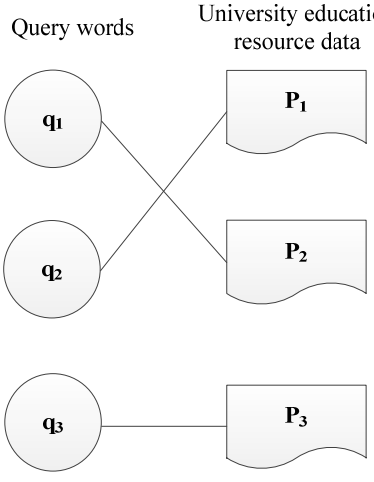
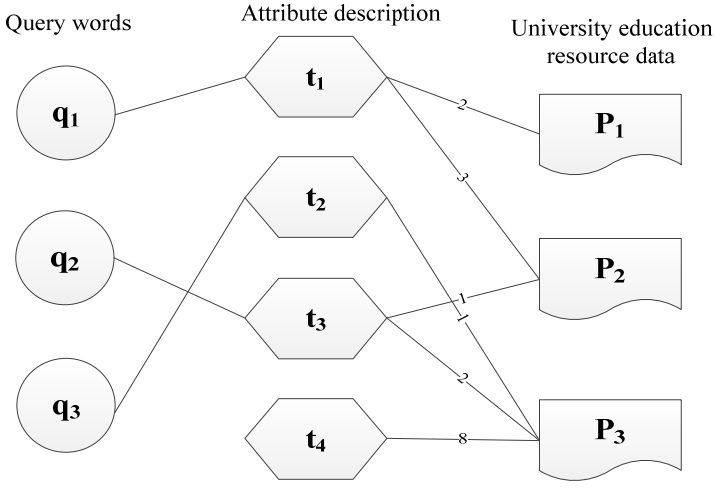


Figure 2 Relationship between query words and educational resource data of this method



As shown in Figure 2, the number on the straight line represents the number of times the attribute labels the education resource data. The similarity between any education resource data can be calculated by using formula (16), and the results are as follows:

$$Sim(p_1, p_2) = \frac{2}{3+2-2} = 0.4 \tag{17}$$

$$Sim(p_2, p_3) = \frac{1}{1+2-1} = 0.33 \tag{18}$$

If we set the similarity threshold to 0.35, when using query word q_1, the search results include educational resource data p_1 and p_2, which effectively makes up for the shortcomings of traditional methods

Generally speaking, the annotation of attributes follows the power-law distribution. Most educational resource data are annotated a few times, and only a few educational resource data have been annotated many times. If the number of times that the attribute t_3 of Figure 2 marks the educational resource data p_3 is changed to 10, the similarity between the educational resource data p_2 and the educational resource data p_3 is calculated as 0.1 using formula (16). The reason why the similarity is affected is that there may be many times to label one of the education resource data, so the originally similar education resource data may be considered dissimilar, affecting the search results. In order to prevent the above situation, this paper defines the education resource data similarity formula as follows:

$$Sim(p_i, p_j) = \sum_{m=1}^{n} \frac{T_m(p_i, p_j)}{T_m(p_i) + T_m(p_j) - T_m(p_i, p_j)} \log \sum_{m=1}^{n} \left(T_m(p_i) + T_m(p_j)\right) \tag{19}$$

When the number of times the label t_3 labels the educational resource data p_3 becomes 10, the similarity of the educational resource data is calculated using formula (19), and the results are as follows:

$$Sim(p_1, p_2) = 0.311 \tag{20}$$

$$Sim(p_2, p_3) = 0.136 \tag{21}$$

In the actual attribute description process, most of the labels labelling the same educational resource data have the same or similar meaning, so the problem of synonyms should be considered when calculating similar educational resource data. This paper uses word net to find synonyms of query words.

After the above calculation, we can get the similarity between any two education resource data.

4 Experiment

4.1 Experimental scheme

In order to verify the performance of the regional advanced teaching resource search optimisation method based on attribute description matching proposed in this paper in practical application, a simulation experiment analysis was carried out under MATLAB simulation software. Set the natural language sample length of the teaching resource database to 2400, and the test training set of semantic text distribution to 120. The SQLerver2014 database is used to construct the Chinese database natural language dataset. The database sample distribution is shown in Table 1.

Table 1 Database sample distribution

Database search sequence	*Rough set*	*Test set*	*Prior set*	*Statistics*
Sequence 1	131.449	68.935	70.066	109.41
Sequence 2	138.657	67.129	68.230	115.41
Sequence 3	129.753	66.290	67.377	108.00

Sequence 4	141.201	67.677	68.787	117.53
Sequence 5	126.360	70.258	71.410	105.18
Sequence 6	128.057	69.581	70.721	106.59
Sequence 7	121.696	70.613	71.770	101.29
Sequence 8	125.088	68.065	69.180	104.12
Sequence 9	129.329	68.806	69.934	107.65
Sequence 10	121.272	68.129	69.246	100.94
Sequence 11	117.880	69.258	70.393	98.12
Sequence 12	115.336	70.839	72.000	96.00
Sequence 13	119.152	67.290	68.393	99.18
Sequence 14	110.247	67.871	68.984	91.76
Sequence 15	137.385	70.290	71.443	114.35

Using the above data to verify the search effect of regional higher teaching resources.

4.2 Experimental index

1 Search accuracy of regional higher teaching resources: the search accuracy of teaching resources reflects the effect of search optimisation of regional higher teaching resources. The higher the search accuracy of teaching resources, the better the search optimisation effect of teaching resources; on the contrary, the worse the optimisation effect.

2 Search time of regional higher teaching resources: the length of search time of teaching resources can reflect the search and optimisation efficiency of teaching resources. The shorter the search time of teaching resources, the better the search and optimisation efficiency of teaching resources; on the contrary, the efficiency of resource search optimisation is worse.

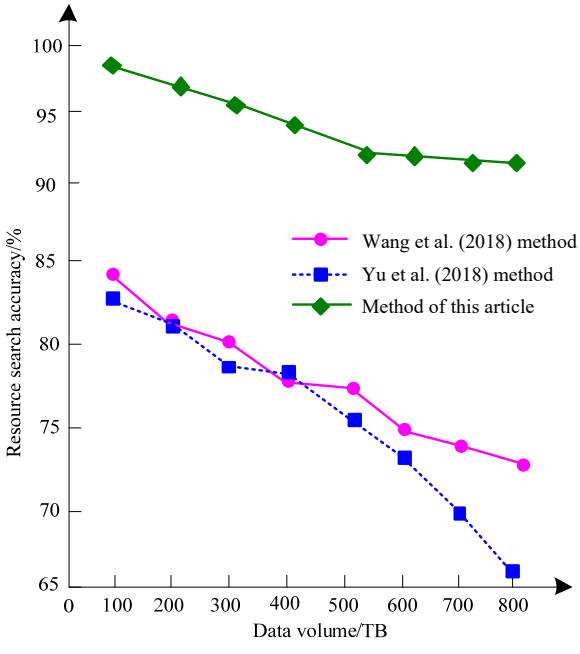
3 Experimental comparison: the search method based on word vector expansion proposed in Wang et al. (2018), the search method based on Ontology proposed in Yu et al. (2018) and the search optimisation method of regional higher teaching resources based on attribute description matching proposed in this paper are used for experimental analysis.

4.3 Result analysis

4.3.1 Comparison of search accuracy of teaching resources

The test set in the teaching resource database is selected as the open source dataset of the simulation experiment part of this paper. According to the sample sequence distribution of the test set, the search optimisation method of regional higher teaching resources based on attribute description matching proposed in this paper, the search method based on word vector expansion proposed in Wang et al. (2018) and the ontology-based search method proposed in Yu et al. (2018) are adopted, Search the regional higher education resources and compare the search accuracy of the three methods. The comparison results are shown in Figure 3.

Figure 3 Comparison results of search accuracy of regional higher education resources (see online version for colours)

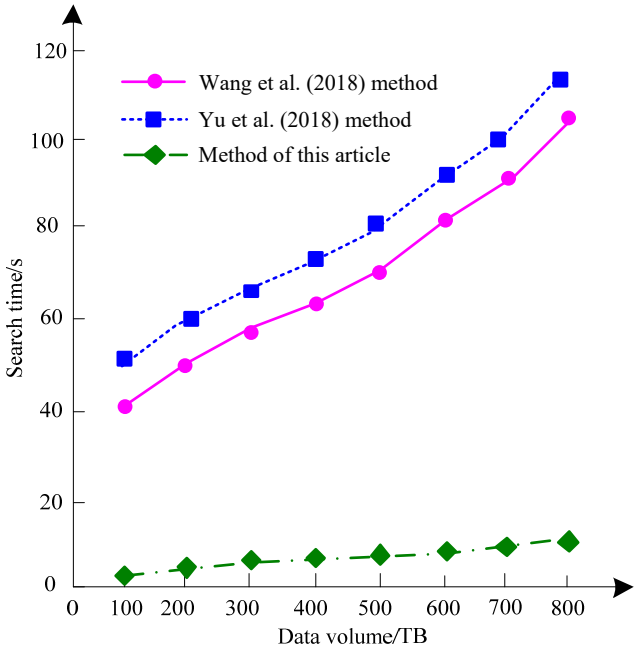


According to figure 3, when the amount of data of teaching resources is 100TB, the teaching resource search accuracy of Wang et al. (2018) method is 84.5%, the teaching resource search accuracy of Yu et al. (2018) method is 82.5%, and the teaching resource search accuracy of this method is 98%; When the data volume of teaching resources is 800tb, the search accuracy of teaching resources of Wang et al. (2018) method is 74.2%, that of Yu et al. (2018) method is 66.5%, and that of this method is 92.3%; The highest resource search accuracy of Wang et al. (2018) method is only 84.5%, and that of Yu et al. (2018) method is only 82.5%. However, the search accuracy of regional higher education resources of this method is much higher than that of other methods, up to 98%, and the search effect is ideal. This is because this method labels the attributes of teaching resources according to attribute description, optimises the search method of teaching resources, and improves the search accuracy of teaching resources.

4.3.2 Comparison of search time of regional higher education resources

In order to further verify the effectiveness of this method, the search optimisation method of regional higher education resources based on attribute description matching proposed in this paper, the search method based on word vector expansion proposed in Wang et al. (2018) and the ontology-based search method proposed in Yu et al. (2018) are used to compare and analyse the search time of regional higher education resources. The comparison results are shown in Figure 4.

Figure 4 Comparison results of search time of regional higher education resources (see online version for colours)



According to Figure 4, when the amount of data of teaching resources is 100 TB, the teaching resource search time of Wang et al. (2018) method is 41 s, the teaching resource search time of Yu et al. (2018) method is 50.5 s, and the teaching resource search time of this method is 1.8s. When the data volume of teaching resources is 800 TB, the teaching resource search time of Wang et al. (2018) method is 108.2 s, the teaching resource search time of Yu et al. (2018) method is 113.6 s, and the teaching resource search time of this method is 11.0 s. The search time of teaching resources in this method is much lower than that in other methods, which shows that the search optimisation effect of regional higher teaching resources in this method is better. This is because this method calculates the word correlation of regional higher teaching resources, uses the method of attribute description, constructs the classification model of regional higher teaching resources, realises the attribute classification of regional higher teaching resources, matches regional higher teaching resources, and improves the search efficiency of higher teaching resources.

5 Conclusions

This paper optimises the traditional search method of regional higher teaching resources through attribute description matching. According to the position of each word item in the language model of regional higher teaching resources, the word correlation is calculated through the correlation degree in the discipline classification tree, the correlation degree of word semantics and the correlation degree of words, and the

attribute description method is adopted through the value, availability, diversity Five attributes, such as creativity and substitutability, construct the classification model of regional higher teaching resources, obtain the resource matching degree, construct the search model of regional higher teaching resources, and optimise it by using the attribute description matching model to obtain the optimal search results of regional higher teaching resources. The following conclusions are drawn through experiments:

1 This method uses attribute description matching to optimise the regional higher teaching resource search model, and improves the search accuracy of teaching resources. When the amount of data of teaching resources is 800 TB, the search accuracy of teaching resources can reach 92.3%, which shows that this method can improve the search accuracy of teaching resources.

2 This paper uses the word correlation calculation of regional higher teaching resources, uses attribute description to construct the classification model of regional higher teaching resources, realises the attribute classification of regional higher teaching resources, matches regional higher teaching resources, and improves the search efficiency of higher teaching resources. When the amount of data of teaching resources is 800 TB, the search time of teaching resources in this method is only 11.0 s.

Although this method can improve the search accuracy of regional higher education resources, it fails to conduct 100% accurate search. Therefore, next, we will study how to achieve 100% accurate search.

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