Application of Internet of Things technology in Human resource recommendation engine

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Abstract: In order to avoid the phenomenon of information overload in the field of human resources, the author proposes a human resource recommendation engine based on Internet of Things technology. Firstly, the application fields of the Internet of Things are introduced, and the human resource recommendation engine is designed, use a mixed referral approach in the HR field. We chose a hybrid recommendation strategy of PLSA and content based on the Internet of Things. The author introduces the human resource recommendation and content-based human resource recommendation of PLSA based on the Internet of Things respectively, on the basis of the above introduction, through the analysis of the existing hybrid recommendation strategy, a weighted hybrid method of PLSA based on the Internet of Things and content-based recommendation algorithm is proposed. In order to verify the feasibility of the proposed IoT-based PLSA and content-based HR recommendation method, we conducted a multi-step experiment. We selected 50 graduating students from A University to participate in this experiment, and the results show that in order to verify the overall effect of the algorithm, with accuracy and recall as evaluation criteria, we conducted experiments on recommendation algorithms of PLSA based on Internet of Things, content-based recommendation algorithms, and recommendation algorithms based on PLSA and content weighting mixture, where, the number of z in PLSA algorithm is 10, the value of β in mixed recommendation is 0.6, the size of N in TopN recommendation is N=5,10,20, and 30. Experiments were carried out on the accuracy and recall of the three recommendation algorithms, the number of z in PLSA algorithm is 10, the value of β is 0.6, and the size of N in TopN recommendation is N=3,5,7,9. The recommendation effect of PLSA based on the Internet of Things is better than that of content-based recommendation algorithm, and the recommendation effect of the combination of the two algorithms is better than either of them.

Keywords: Internet of Things technology; Human resources; Recommendation engine; Recommendation algorithm.

1. Introduction

With the rapid development of information technology and the Internet, network information services have been reflected in all aspects of human life, from e-commerce, instant messaging, network search, social platforms, online games and other mobile Internet, the number of network users is increasing at an unprecedented speed [1]. Faced with a wealth of information, like tens of thousands of movies on Netflix and millions of books on Amazon, delicious has more than 100, 000 web page data collections and so on, the plethora of information presented to users makes it difficult to efficiently find the information they need in a short period of time, this creates the problem of "information overload". In order to solve this problem, a classification directory and search engine based on the Internet of Things are introduced. Among them, there are famous companies in foreign countries such as Yahoo and Amazon [2]. Categorization simply classifies Web site information into different categories or topics, in order to find according to the category, but with the rapid development of the Internet, the use of classified directory sites can only involve a limited number of popular websites, more and more can not meet the needs of users. In this situation, search engines appear, search engines through the user input query information keywords to get the information they need, typical representatives are Google, Baidu and other companies. As a tool to provide personalized service, recommendation system is considered to be the most effective way to solve resource overload. This method has been widely applied in various fields, such as Amazon, Taobao,

Jingdong and other mainstream e-commerce recommendation, music recommendation, movie recommendation, etc. In addition, the development of information technology and the Internet has also changed the way of recruitment and job hunting in the field of human resources, the existing job hunting channels include contacting the recruiter directly, obtaining the job information of the job being recruited through the Internet, applying for jobs through specialized employment service agencies, and making full use of personal social relations for job hunting [3].

As a tool to provide a personalized service, the recommendation system is regarded as the most effective way to solve the resource overload. This method has been widely used in various fields, such as Amazon, Taobao, JD and other mainstream e-commerce recommendation, music recommendation, recommendation, film recommendation, etc.In addition, the development of information technology and network has also changed the way of recruitment and job hunting in the field of human resources. Existing job hunting channels, such as directly contacting recruiters, obtaining job information being recruited through the network, job hunting through specialized employment service agencies, and making full use of personal social relations for job hunting. Foreign literature found that the progress of information technology and the expanding network application, more and more job seekers are from the traditional way to use the Internet to find a job, through the network for the research, research found that in 1994 only 15% of the unemployed through the network job, the number soared to 50% to 1998.However, with the increase of job information and job seeker information, the problem of information overload appears in this field. In the face of massive job information, job seekers cannot find their satisfactory job in time, and in the face of a large number of candidates, recruiters cannot efficiently select the suitable talents. Traditional information systems can not solve this problem very well, and they need more adaptive information systems to more efficiently process large amounts of job and candidate information. We know that the recommendation system is an effective tool to solve the information overload, and applying it in this field is a good solution to solve the information overload in this field.In addition, the match between person and position is mainly defined in two aspects: one is the match between candidate expectations and position provision, and the other is the match between job responsibilities and candidates' ability. From this definition, it follows that HR recommendation is not a traditional one-way recommendation. In the traditional e-commerce recommendation system, users can choose the goods that meet their interests according to their own hobbies, but the opposite way is not, that is, the goods cannot choose the users according to their own hobbies.But in the field of human resource recommendation, this is not the case. It is a two-way recommendation, that is, to consider the preferences of the employer (the requirements of the job), but also the preferences of the job seekers. There is very little research on how to better apply the recommendation system in the field of human resources, and the research in this paper has some practical significance. With the development of information technology and the Internet, the problem of resource overload is becoming more and more prominent.The emergence of this problem is partly alleviated by classified directories and search engines, which filter the information by classifying it and entering the corresponding search keywords entered by the user, respectively. However, its popular and passive mode of providing information services cannot provide people with personalized information. The recommendation system can proactively recommend projects conforming to their personalized needs according to their historical information or the preferences of other users with similar interests to them.As shown in Figure 1.

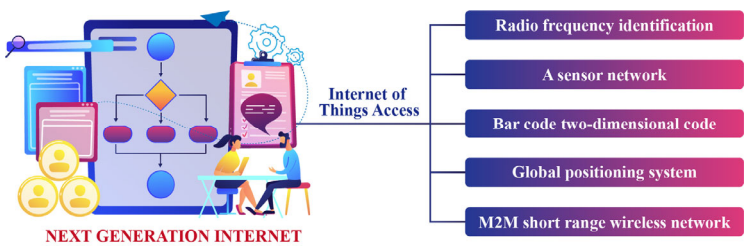

Figure 1. Key Technologies and applications of the Internet of Things (high-end)

2. Application of the Internet of Things

The Internet of Things (iot) is a new generation of network information technology, which can implement intelligent management of daily production, sales and operation of enterprises through various sensor devices [4]. And the Internet of things technology is not limited by time and place, can effectively realize the free communication between things and things and people and things, through comprehensive perception, transmission and intelligent processing, further realize the efficient management of enterprises.Applying the Internet of Things technology to enterprise information management, through the Internet of things technology, the enterprise's product sales, as well as the use of vehicles, goods and resources, can be monitored throughout the process, while ensuring product quality and safety, the efficiency of enterprise resource utilization is greatly optimized. The ten key areas of iot application are smart grid, smart transportation, smart logistics, smart home, environment and safety detection, industry and automation control, medical and health, fine agriculture and animal husbandry, finance and service, national defense and military.

3. Design of human resource recommendation engine based on the Internet of Things

3.1 Architecture of human resource recommendation engine based on Internet of Things

In the field of human resources, we mainly use the following user characteristic data:

(1) Attribute data of job seekers and recruiters. The attribute data of the applicant mainly includes basic information such as name, gender, age, home address, education experience, internship and work experience, etc. The attribute data of the recruiter mainly includes company profile and position profile, etc. [5].

(2) Behavioral data of job seekers and recruiters. This includes what job candidates have looked at and what candidates have been looked at by recruiters for specific positions.

When making recommendations, we should take all the data mentioned above and the recommendation tasks into consideration in one system, the human resource recommendation system is divided into modules of a single recommendation engine, and the specific information is shown in Figure 2 below.

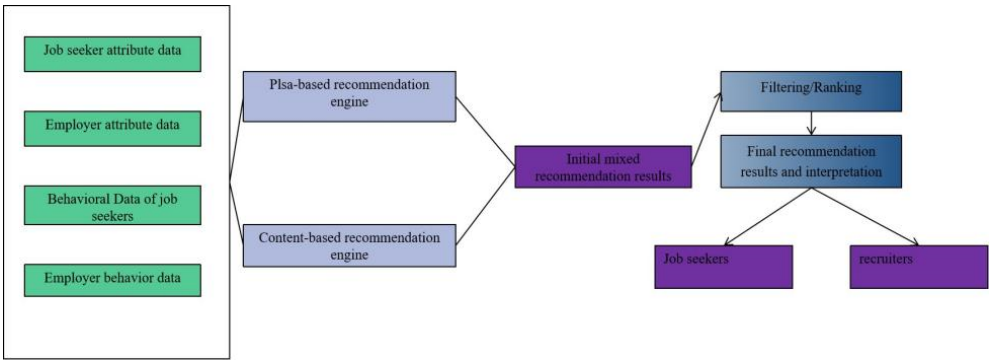

Figure 2. Human resource recommendation system engine architecture diagram

In Figure 2, the module on the left is mainly responsible for acquiring and storing various types of user data, including attribute data and behavior data of recruiters or job seekers [6]. The intermediate module part depends on the data used, the recommendation engine formed by adopting different recommendation strategies, such as content-based recommendation engine and PLSA-based recommendation engine. The module is mainly responsible for mixing the results produced by different recommendation engines according to certain strategies, generate an initial list of recommendations that are filtered and ranked, such as by looking at items already viewed by job seekers or recruiters, and by removing outdated job postings, present the final list of recommendations and explanations to the user.

3.2 Human resource recommendation engine of PLSA based on Internet of Things

As this method is one of the model-based collaborative filtering and recommendation methods, it mainly uses the behavior data of the recruiter and the job seeker (the author mainly refers to the click-browsing behavior of the recruiter and the job seeker). Behavior extraction and transformation is mainly to extract the browsing behavior data of job seekers or recruiters stored in the database and convert it into a form that can be easily calculated, the method adopted by the author is to form jobseeker - position matrix or jobseeker - job matrix [7]. PLSA model training is based on the data matrix processed in advance, the PLSA model is established, and the EM algorithm is used to train the model, and the parameter set is solved. Recommendation prediction refers to calculating the recommendation value of each project set according to the candidate project set (job seeker and position set) and the parameters obtained by PLSA model training, the recommendation value here is basically the probability that a candidate will look at a particular job or the probability that a recruiter will look at a particular job. Finally, an initial list of recommendations is generated by sorting them according to their size.

3.3 Human resource recommendation engine based on Internet of Things content

When using the content-based recommendation method, the attribute information of the recruiter and the job seeker is mainly used, but the user's behavior data should also be taken into account when modeling the user's interest. Firstly, the attribute information of job seekers and recruiters is extracted from the database and converted into text, word segmentation is carried out by word segmentation tool, and then corresponding tf*idf values are calculated by vector space model to form feature vectors representing job seekers and recruiters respectively. User interest model is mainly based on the behavior characteristics of job seekers or recruiters, find out the attributes of the objects that job seekers or recruiters are interested in, and combine these features according to a certain method (the author uses Rocchio algorithm). After the user interest model and the feature vector set of the recommended object are obtained, the similarity between each candidate recommended object and the interest model can be calculated, finally, the top k with the largest similarity calculation are used as the initial recommendation list for this user. Through the above analysis, we can get the recommendation engine formed by different recommendation strategies, which may have some differences in the implementation process.

3.4 Experimental data description

In order to verify the feasibility of the proposed human resource recommendation method based on PLSA and content, we conducted a multi-step experiment. We invited 50 students who are about to graduate from A University to participate in this experiment, they come from different colleges and have different professional backgrounds [8]. First, we asked the 50 students to submit their personal resumes through our pre-implemented WEB interface, which would be stored in a database. This process is similar to the resume registration process when applying for a job on a dedicated job site, such as a new graduate. The 50 students were asked to provide the following information:

(1) Basic personal information. This includes information such as name, date of birth, political status, phone number and email address.

(2) Educational information. Include information about the institution of graduation, education or degree, major courses, grades, etc.

(3) Internship Work experience. Include information such as company name, form of employment, industry, job title and responsibilities.

(4) Information on language ability. This includes the languages spoken, certificates and grades obtained.

(5) IT capability information. Include information on skill type, duration of use, proficiency level, etc

(6) Other information. Include information about being a class leader, awards (scholarships, etc.), published papers or patents, etc.

Next, we grabbed 200 randomly selected jobs from specialized job sites (Dajie and new graduates), considering that the students in the experiment were all about to graduate and all had full-time jobs. In addition, in order to ensure job diversity, the 200 job listings cover 10 fields, including finance, IT, accounting, marketing, languages, law and administration. We sorted out the job information obtained and stored it in the database in a unified format through the WEB interface, these jobs mainly include the following information:

Employer information: Including company name, company size, industry, company profile, etc.

Job information: Including job title, recruitment target, job responsibilities, job requirements and other information.

In order to make content-based recommendations, we extracted the resume information of these 50 students from the database and stored it in 50 corresponding text documents, then the stutter word segmentation tool was used to segment the 50 documents, remove noise words and stop words, and obtain frequent words [9-10]. Then, the 50 frequent words in the text document were summed, develop a domain dictionary for the 50 students. Finally, the feature vectors of the resume information of the 50 students were obtained by vector space model. For 200 job information, in order to obtain their respective feature vectors, we use the same method as above. These feature vectors are stored in the database in the form of data.

On the basis of the above steps, we present the 200-job information in the form of an information list, which is mainly displayed in the form of company name, job title, working place, salary and job summary [11]. The 50 students were then asked to click through information about jobs they were interested in according to their job search tendencies and future career development plans. Similarly, we also present the 50 students in the form of a list, which is mainly in the form of the student's name, major, school and academic record. In addition, we have invited two people with HR experience, each of the 50 students was clicked on for each position. Finally, we stored the behavior data of these 50 students and 2 HR students into the database respectively.

4. Results and analysis

4.1 Job recommendation effect analysis based on the Internet of Things

Job recommendation based on the Internet of Things is mainly to recommend suitable jobs to job seekers, when conducting this experiment, we randomly selected the browsing behavior data of 10 students for 40 positions as the test set, and the remaining data as the training set. Table 1 shows the results of recommending 10 positions for the top five students in the test set, these 10 positions are arranged according to the recommendation value calculated by the linear hybrid recommendation algorithm based on PLSA and content proposed by the author, where, Y represents that students actually browse the position, and N represents that students do not browse the position [12].

Table 1. Results of 10 positions recommended by the top five students

S001	S002	S003	S004	S005
008 (Y)	010 (Y)	008 (Y)	007 (Y)	008 (Y)
006 (Y)	008 (Y)	010 (Y)	008 (Y)	007 (Y)
010 (N)	004 (Y)	005 (Y)	004 (N)	010 (Y)
012 (N)	003(Y)	020 (Y)	009 (N)	011 (N)
009 (N)	014(N)	014 (Y)	006 (N)	012 (N)
001 (Y)	006(Y)	009 (Y)	010 (N)	006 (N)
006 (N)	012(Y)	001 (N)	001 (N)	015 (N)
013 (N)	021 (Y)	003(N)	016 (N)	016 (N)
005 (N)	007 (N)	016(N)	003 (Y)	001 (N)
021 (N)	005 (N)	007(N)	005 (N)	004 (N)

As we can see from the Table above, the algorithm makes accurate recommendations for students 002 and 003, the recommendation for student 001,004,005 is not very precise, but the top few

recommendations are the positions that students actually browse. So, in general, the algorithm is good. In order to verify the overall effect of the algorithm, we take accuracy and recall as the evaluation criteria, and conduct experiments on PLSA-based recommendation algorithm, content-based recommendation algorithm, and PLSA-based and contentweighted hybrid recommendation algorithm, respectively, where, the number of z in PLSA algorithm is 10, the value of β in mixed recommendation is 0.6, and the size of N in TopN recommendation is N=5,10,20, and 30, respectively. The experimental results are shown in Figure 3 and 4 below [13-14].

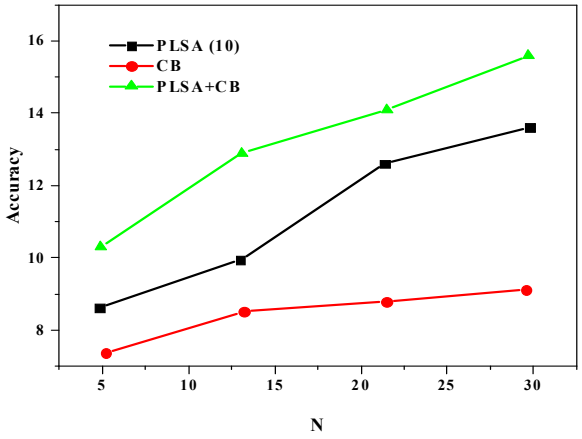

Figure 3. Accuracy curve of job recommendation

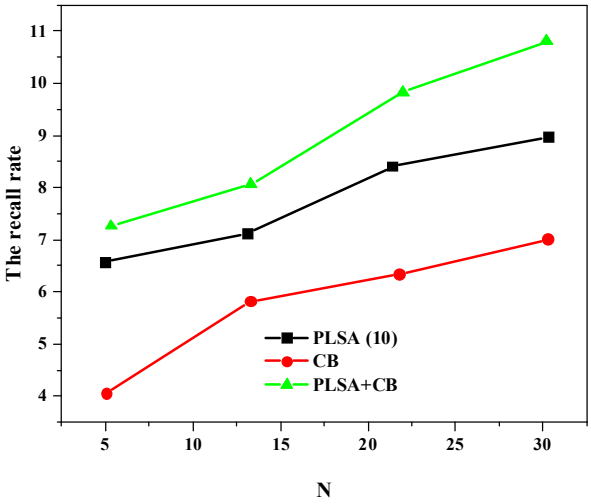

Figure 4. Recall curve of job recommendation

In the figure above, PLSA based on Internet of Things represents collaborative filtering recommendation based on PLSA algorithm, CB indicates content-based recommendation, and PLSA+CB indicates mixed recommendation based on PLSA and content. As shown in the above data graph, we can conclude that the recommendation effect of PLSA-based recommendation algorithm is better than that of content-based recommendation algorithm, however, the recommendation effect of mixing the two algorithms is better than that of any recommendation algorithm [15]. However, the recommendation effect of content-based recommendation algorithm is the worst, which is mainly because content-based recommendation algorithm mainly relies on word segmentation technology. Convert a text file into a stream of keywords, however, these keyword streams can only represent some aspects of the recommended object, but not all aspects of the recommended object. For example, it does not consider the relationship between keywords.

4.2 Analysis of job seeker recommendation effect based on the Internet of Things

Job recommendation based on the Internet of Things (iot) is mainly about recommending suitable job seekers to specific positions. When conducting this experiment, we randomly selected 40 positions and HR's browsing data of 10 students for these 40 positions as the test set, the rest is the training set. Table 2 shows the results of recommending 5 job seekers for the top 10 positions in this test set, these 5 job seekers are similarly ranked according to the recommendation value calculated by the recommendation algorithm based on PLSA and content proposed by the author, where Y represents that the applicant's information is actually viewed, and N represents that it is not [16].

Table 2. Results of referring 5 applicants to 10 positions

J001	J002	J003	J004	J005
006 (Y)	004 (Y)	008(Y)	006 (Y)	005 (Y)
007 (Y)	009 (N)	006 (Y)	002 (N)	003 (Y)
005 (Y)	006 (Y)	004 (N)	007 (N)	001 (Y)
010 (N)	008 (N) .	003(Y)	005 (N)	009 (N)
002 (Y)	001 (N)	010 (N)	010 (N)	007 (N)
J006	J007	J008	J009	J010
001(Y)	004 (Y)	010(Y)	001 (Y)	005 (Y)
004 (N)	006 (N)	005 (N)	006 (N)	001 N)
006 (N)	009 (Y)	003 (N)	004 (Y)	009 (N)
009 (N)	007 (N)	004 (N)	003 (Y)	003 (N) .
008 (Y)	008 (N)	007 (N)	005 (Y)	002 N)

As can be seen from the above Table, the recommendation effect of the algorithm on J001, J003, J005 and J009 is better, the other job recommendations were less accurate, but the top candidates predicted by the algorithm were candidates who had already been viewed. Similarly, in order to verify the overall effect of the algorithm, we conducted experiments on the accuracy and recall of the three recommendation algorithms, the number of z in PLSA algorithm is 10, the value of β is 0.6, and the size of N in TopN recommendation is N=3,5,7, and 9, respectively. The experimental results are shown in Figure 5 and 6 below [17-18].

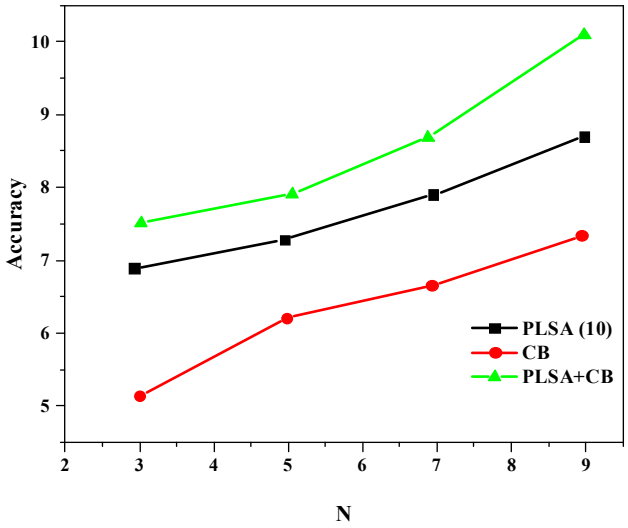

Figure 5. Recommendation accuracy curve of job seekers

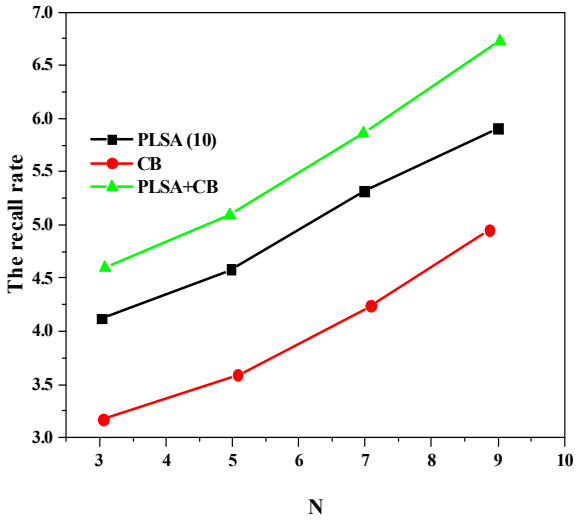

Figure 6. Recommended recall curve of job seekers

Based on the above data Figure, we can also conclude that the recommendation effect of PLSA based on the Internet of Things is better than that of content-based recommendation algorithm, and the recommendation effect of the combination of the two algorithms is better than that of any recommendation algorithm.

5. Conclusion

The author studies the application of Internet of Things technology in human resource recommendation engine, the proposed hybrid recommendation algorithm of PLSA and content based on Internet of Things is verified by experiments. It explains in detail the acquisition of experimental data, experimental evaluation standards, experimental design, and finally through experimental verification, the experimental results are analyzed, and the experimental results show that the hybrid recommendation algorithm of PLSA and content based on the Internet of Things has a good effect on the recommendation of job seekers and positions in the field of human resources. In addition, from the overall experimental results, we can conclude that the recommendation effect of the hybrid recommendation algorithm based on PLSA and content of the Internet of Things is better than that based on a single PLSA and content.

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