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Application Research of Intelligent Search System Based on Clustering Algorithm

Abstract: - In this paper, a multi-agent oriented personalized information retrieval method is proposed. The system is composed of 5 agents and 2 other components. The design highlights the personalization and real-time of the information obtained by users, and has the characteristics of intelligent retrieval and active retrieval. Then this paper studies it from three aspects: user model, system learning model and individual information model. Then a grouping gravity search algorithm is proposed. Compared with conventional gravity search, group gravity search is carried out for a specific decoding strategy. This algorithm is a new gravity search algorithm suitable for packet coding, which makes the packet search process approximate to the iterative optimization of classical gravity algorithm. Finally, the effectiveness of the proposed method is verified on various typical experimental cases. Experiments show that the proposed algorithm has higher classification performance than other intelligent group algorithms.

Keywords: Agent; Personalized Information Search; Intelligent Retrieval; Block Coding; Gravity Algorithm; Classification Error Ratio.

I. INTRODUCTION

At present, the amount of information on the Internet is increasing explosively, but the development of broadband is far behind the increase in the number of Internet users and the requirements of Internet users. Due to the non-organization and heterogeneity of data on the Internet, its availability and credibility are constantly in flux. Invalid search is the main cause of network congestion and the main reason of restricting the development of Internet information business [1]. At present, the most widely used business search engine, its search speed, wide range of information, fast update cycle, and have their own characteristics, for the majority of users love. However, in the professional business search engine, there are some shortcomings, such as: non-uniform classification standards, unclear search expression, and lack of efficient screening and comparison criteria [2]. Google has released a personalised search software called iGoogle. Over the next two years, the major search engines began to publish their own personal information, such as Yahoo! 's My Yahoo! LeapTag released the LeapTag system. All systems have a strong personalized search home page, can record the user's browsing history, can be customized according to the needs of users, actively provide users with relevant information; The rationale is: "The more trust you send to search engines, the more information will be left out." Although each of them has its own characteristics, they all have four defects: the level of personalization is not high enough to meet the needs of most people; In order to obtain more relevant results, it is necessary to rely on a large amount of user data.

The root cause of the lack of personalization tools in search engines is that the complexity of the services it serves is too high to meet the needs of specific specific areas [3]. The personalized retrieval system developed in this topic can be realized by establishing a specific domain database in a specific specific domain on the Internet. Introducing agent technology into this architecture is a new research field and also a new research direction of information retrieval system. Agent is a kind of intelligent individual who senses and influences the external environment. Able to use existing knowledge to solve problems; In addition, the system has the characteristics of autonomy, reactivity and adaptability, and can exchange and collaborate with other agents. In this system, in addition to the application of agent technology, artificial intelligence, search engine ODP, active information dissemination and other methods are introduced [4]. As the most popular and most important data analysis method at present, it aims to cluster a group of data so that all the data in the same cluster are the same, but there are great differences in different clusters, which is called heterogeneous data. Data clustering has important applications in machine learning, pattern recognition, image processing, data mining and so on. In recent years, inspired by the law of gravitation and the law of target motion, the gravity search method has been introduced

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into the research. GSA aims to solve optimal problems, is similar to majority-based heuristics, is more resilient, and has obvious advantages in enhancing the balance between search and development [5]. The algorithm uses a global optimization algorithm to make the individuals of the population tend to the optimal K solution sets.

The architecture pattern of the system is composed of 3 A-gent, 2 mobile agents, 1 database and 1 knowledge base. The personalized retrieval strategy is discussed from user model, interest learning, database and so on. The GSA method presented in this paper differs from ordinary GSA in two aspects. First of all, this project plans to use the package coding method to map the associated cluster structure with the corresponding relationship in the solution process [6]. Secondly, aiming at the specific cluster structure, GGSA method is used to give the localization and rate calculation method of the solution scheme suitable for packet coding. The GSA method is evaluated by analyzing 13 typical samples. For a known cluster set of D, GGSA tries to extract 75% of the cluster center from a known sample set, which is the training sample of GGSA. The classification error ratio (CEP) is used to evaluate the clustering performance of the algorithm in the test set.

II. SEARCH SYSTEM DESIGN BASED ON CLUSTERING ALGORITHM

A. System Architecture

This paper integrates agent technology and artificial intelligence, and proposes a user-specific information retrieval platform PISMA based on search engine as the platform. The architectural model of the system is shown in Figure 1 (image cited in Modeling local interest points for semantic detection and video search at TRECVID 2006).

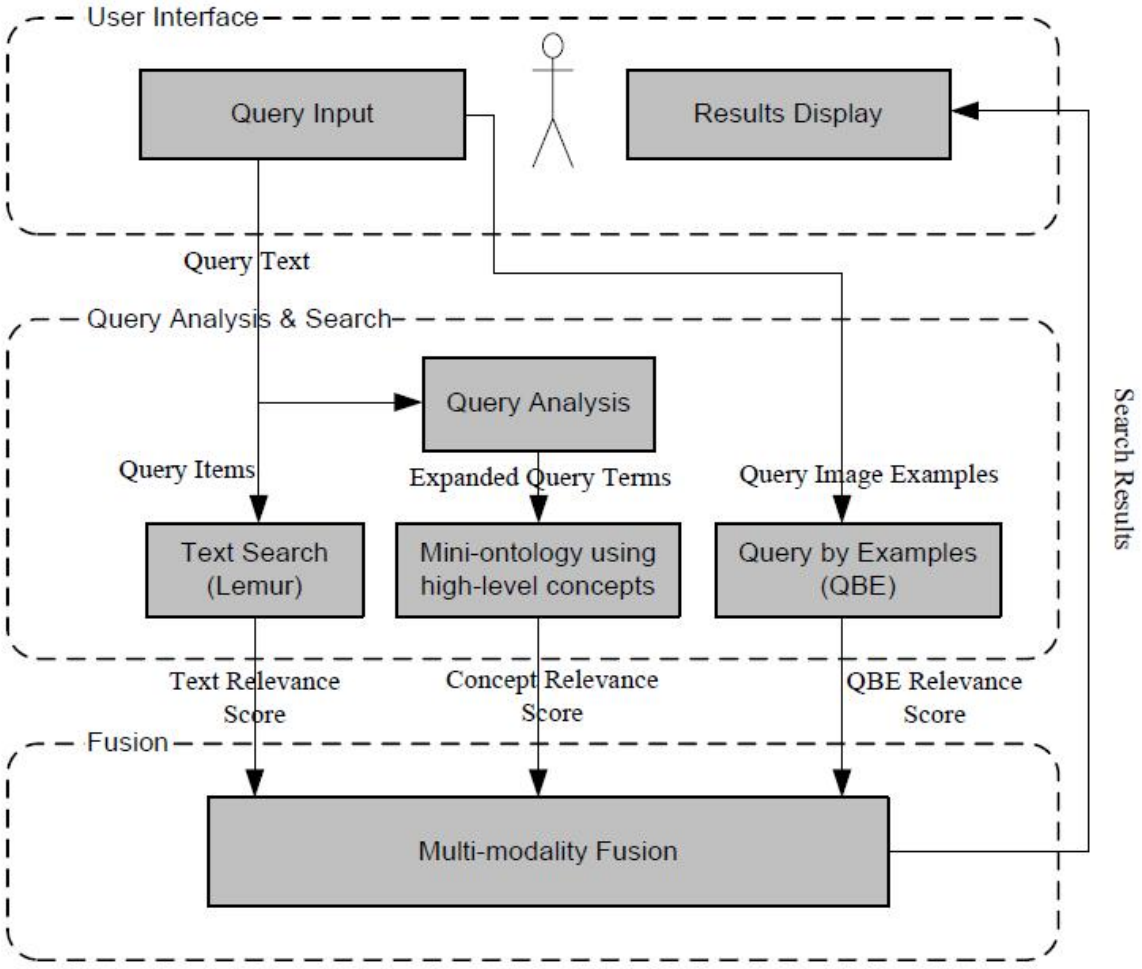

Fig.1 Automatic search system architecture

a) User Agent

Among them, the user agent is the interface between PISMA and the user, and also the starting and ending point of personal information search [7]. User agent consists of interface module, behavior collection module and user behavior analysis module. Its main functions are as follows: transfer information, analyze and process user input, and make statistics on user behavior.

b) Managing Agents

PISMA system focuses on the management agent, obtains the personal information of the customer through the interaction with the customer agent, and provides the inferred customer interest keywords to the information retrieval agent [8]. The system is composed of interface module, inference module and information processing module, and function modules of information transmission, intelligent reasoning, search terms and search results.

c) Information retrieval agent

This is the interface between PISMA and the Internet, which determines the relevant parameters of the search according to the data given by the administrator agent, and feedbacks the results of the query to the administrator user. The module includes four modules: task receiving module, mobile agent generation and dispatch module, mobile agent path planning module, and information receiving module [9]. The query process is carried out simultaneously in the local database and on the Internet, and the contents of the database in the database change as the relevant information in the remote database changes. In this paper, a path optimization method of robot based on mobile robot is proposed, and the corresponding algorithm is given.

1) Route planning module

Path planning includes three aspects: network planner, monitor, and whiteboard server. Immediately after the mobile agent receives the task of finding the message, it contacts the planning module to obtain the destination address found by the mobile agent from the board server; The scheduler sends the address information of a destination to the network monitor, and sends related information to the scheduler, such as destination routing information, network connection delay, bandwidth, etc. Through the understanding of the above information planning module, the access path and the scheduled return time of the action agent can be analyzed [10]. In addition, the routing anomalies occurring during the movement are provided to the route design module based on the collected telematics. A new method based on routing mechanism is proposed. The components of a route plan are shown in Figure 2 (image cited in the Intelligent route planning system based on interval computing).

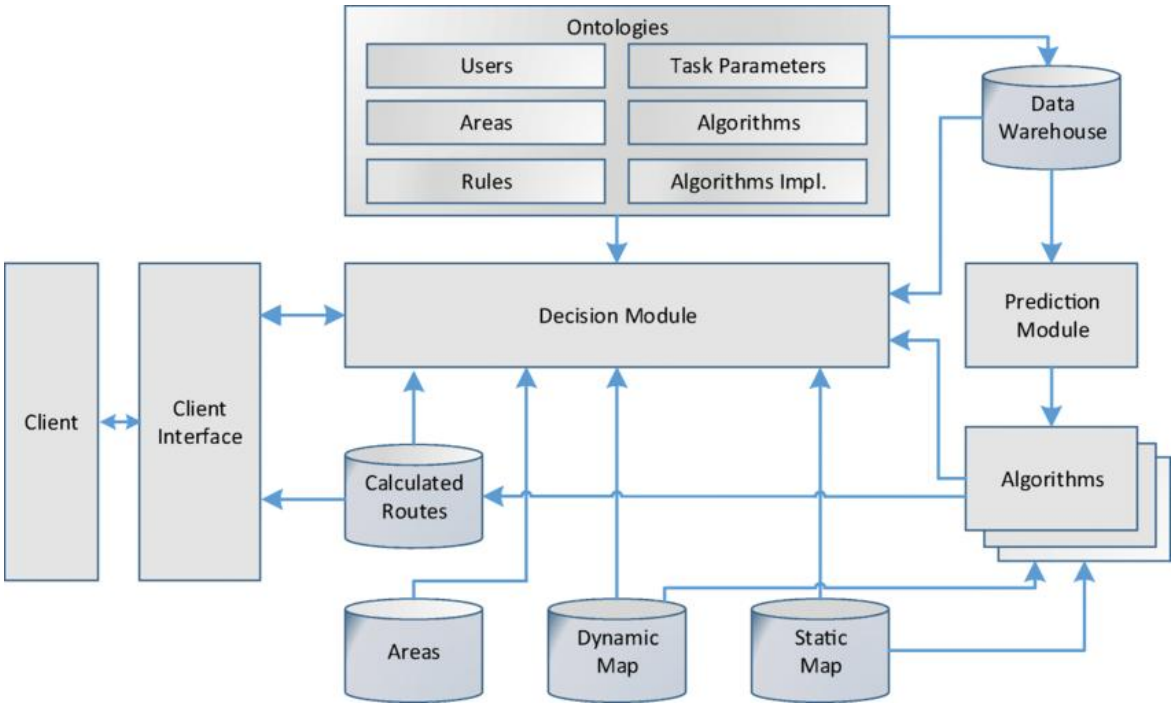

Fig.2 Route planning module

2) Handling Search Exceptions

In the process of dispatching agents, due to the occurrence of some emergencies and the phenomenon of not being able to return in time, so there will be a periodic detection mechanism in the process of generating and dispatching agents. The mobile agent that exceeds the specified time limit will stop accessing the remote database and send a new mobile agent to communicate with the original mobile agent and return [11]. The original mobile agent continues to access the remote database after the communication ends. This can eliminate exceptions and shorten the system delay. The main content of the communication is: the original mobile agent submits the

obtained information to the new mobile agent. When the new mobile agent completes the communication, the new mobile agent sends the received data to the message retrieval agent.

3) Information processing module

The system not only processes the web data obtained by the data acquisition module, but also realizes the data exchange with the "data retrieval" module described below. By parsing the format of Web pages, the method determines whether Web pages are written in HTML, XML or other markup languages, and selects corresponding interfaces for each markup language to process. Then, the generated documents are automatically segmented, and the network structure mining technology is used to analyze them. The index base and rule base are constructed [12]. When retrieving data, indexes and rule bases are used for pattern matching. Through the analysis of information query logs, the user's behavior habits are found and fed back to the information processing module, so as to achieve continuous learning and improvement. The processing flow of all the information is outlined in Figure 3 (image cited in SmartCovSens: A Multimodal Approach for Detection of COVID-19).

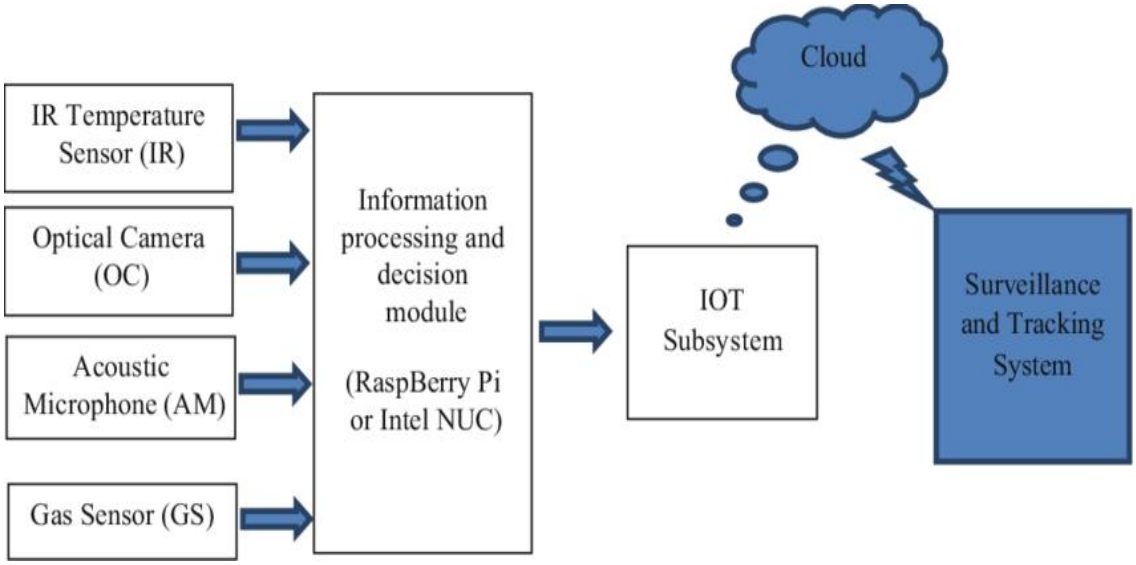

Fig.3 Information processing module

a) Mobile agent

A mobile agent is an organizational structure composed of software that can communicate and communicate freely between different computers. In this system, the mobile agent is generated by the information retrieval agent, and then sent to the remote database, the information that meets the requirements is returned to the information retrieval agent in the form of documents, if the task cannot be performed, the mobile agent dies. The following describes the mobile agent model, communication between mobile agents, and the security of communication.

1) Mobile Agent Mode

The system includes communication control module, data receiving module and motion control module. In order to reduce network congestion, only two mobile agents can be generated in this system. This article refers to the first mobile agent dispatched to M_Agent1 as M_Agent2, and then both mobile agents dispatched to M_Agent2 are completely isomorphic. As mentioned earlier, because M_Agent2 does not require access to the remote information resource collection module, it is not visible. When two mobile agents communicate, the communication component and the data flow in the database are reversed [13]. Communication control module includes communication and security check; The mobile control system consists of four subsystems: mobile control center, timer, routing policy table, routing state table, etc. The data acquisition module mainly includes three aspects: data acquisition, data formatting and the database used to store the data. The Mobile Agent and the communication model are shown in Figure 4 (the picture is quoted in An Overview of Mobile Software Systems).

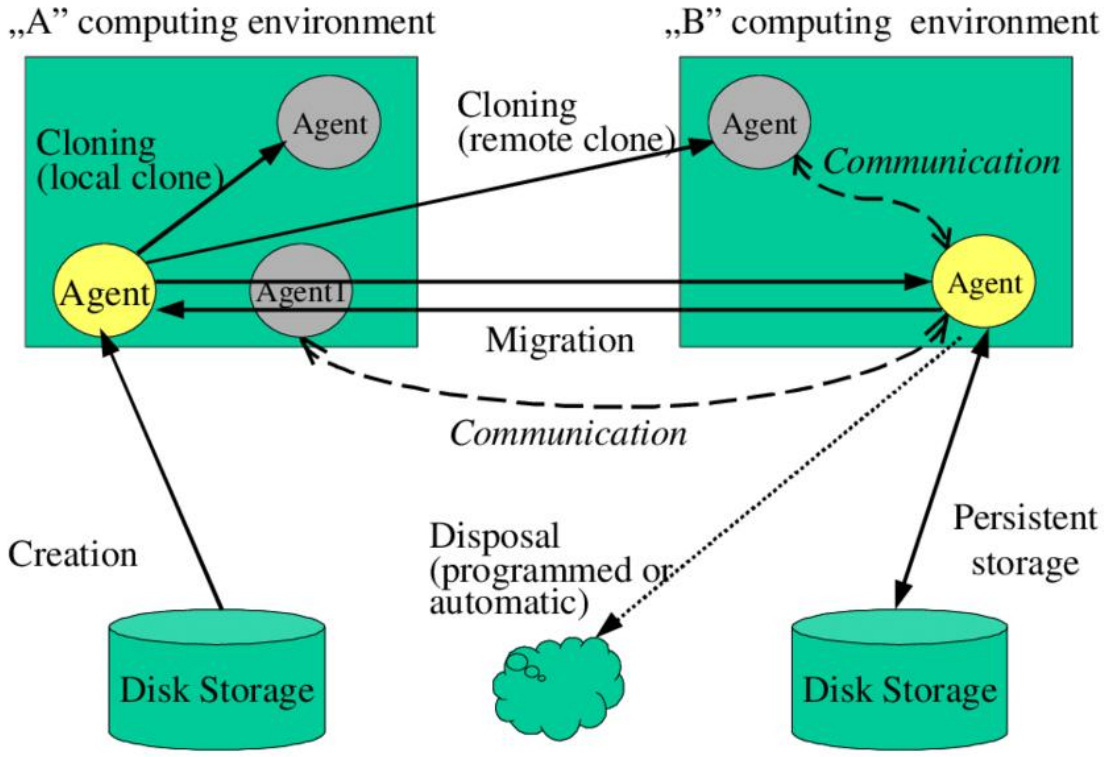

Fig.4 Mobile Agent and communication model

2) Communication between mobile agents

The communication of emergency information is the central link of communication. Usually only M_Agent1 is generated and sent without using a communication authority. M_Agent2 will be dispatched in case M_Agent1 cannot return on time due to a network exception to prevent the system from waiting for a long, unexpected time [14]. Aiming at the original mobile agent location and unpredictable network failure, a time-out return based method is proposed.

3) Security of mobile agents

In a series of behaviors generated, sent, searched, communicated, returned and submitted by the user, the user must perform security protection. The retrieval procedure performs a write to action agent 1; The communication program only reads from MobileAgent1, and MobileAgent2 only writes. During the submission of information, read the action agent 1 and Action agent 2. The access and access rights of mobile agents in each time period are effectively monitored to prevent potential malicious tampering [15]. In addition, to avoid cyber attacks that impersonate mobile agents, it is necessary to be authenticated when submitting data. Because of the small amount of data, RSA encryption is used in the authentication process.

4) Message Filtering Agent

An image screening method based on individual features is proposed. Content filtering, cooperative filtering and economical filtering are three ways to realize information filtering [16]. This article uses content filtering technology to create a level of personalization at the user level, which is achieved through a custom user profile table. In this paper, a method based on semantic analysis and semantic analysis is proposed. After the keyword is submitted to the search engine, the search engine feedbacks the initial query results to the filtering agent, and the filtering agent uses the user's personal information list to filter the initial query results and send valuable messages to it. This process is shown in Figure 5 (image cited in Information 2018, 9(11), 262).

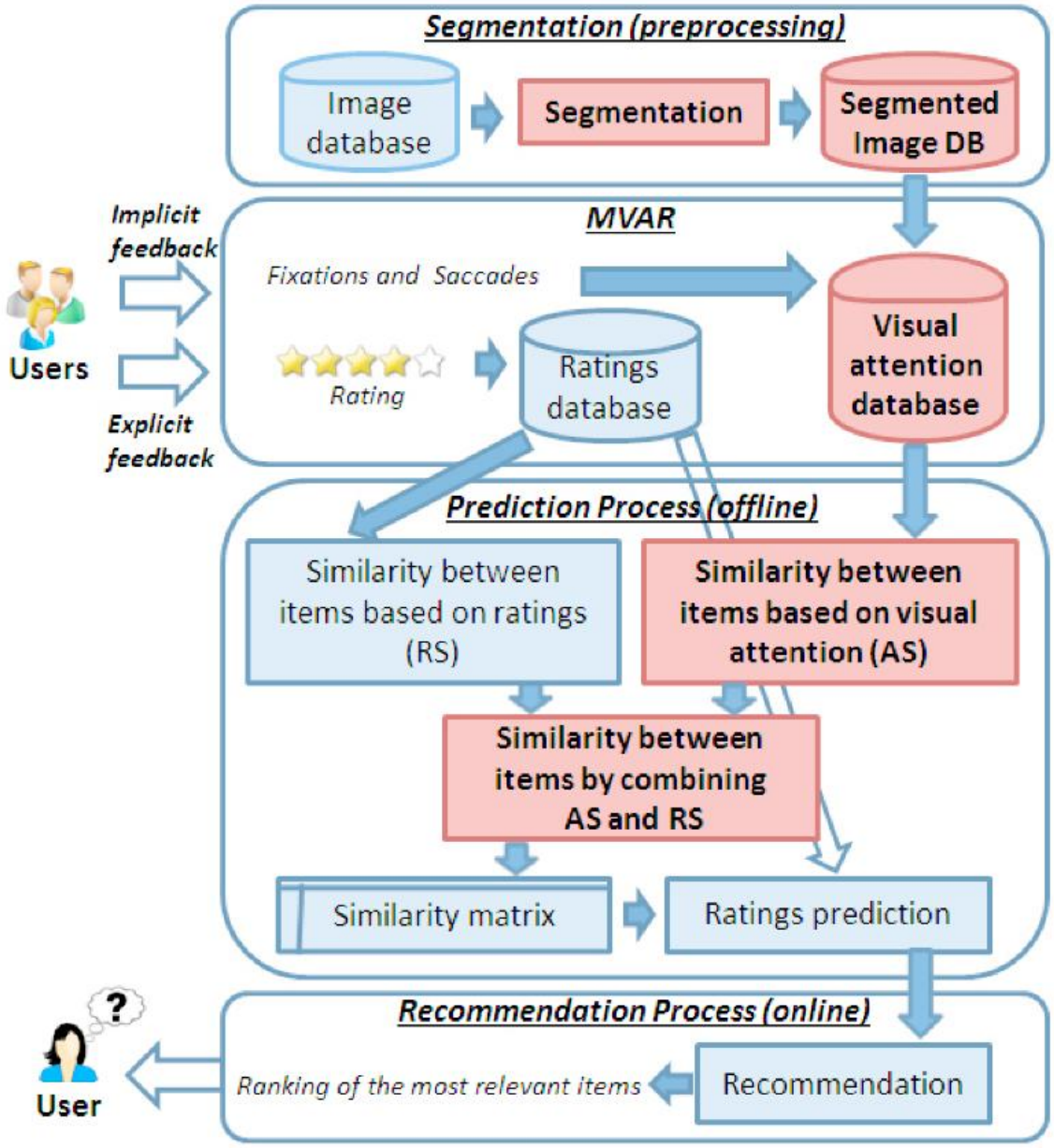

Fig.5 Information filtering process

B. Research on user-oriented personalized retrieval mode

At present, most of the mainstream business search engines adopt the classified search method, which is fast, wide range and short update cycle, but its shortcomings are that its personalized search ability after search is poor, and it provides users with a large number of messy information after search. Some scholars have conducted a study and found that when people use search engines to query information, the average number of pages is only 2.35, and 85-92% of people will only visit 2 pages. Personalized search has better performance than unpersonalized search. A unique feature of PIMSA is its search function, which is mainly conducted through user agents and administrative agents [17]. The user model, the system interest learning model and the design and use of the personal information database lay a solid foundation for the system to complete the personalized information retrieval.

a) User Mode

This project proposes an interest model based on user interaction behavior, which is transformed into an interest model. The knowledge base is trained directly through user input, user behavior and hidden expression. Figure 6 is the Personalized Search pattern (image cited in FedPS: A Privacy Protection Enhanced Personalized Search Framework).

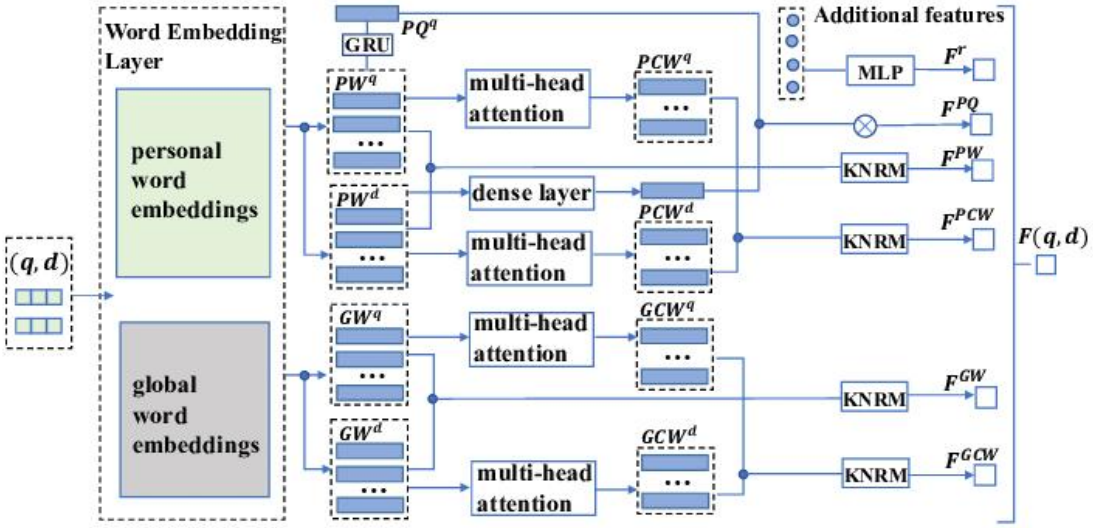

Fig.6 Personalized search model

b) Learning with interest

Personalized retrieval is to provide personalized services for different users, that is, to adopt corresponding service strategies to meet different needs according to the needs of users. When building the user model, first of all, the user's data should be analyzed by interest, and then the user's behavior should be mined [18]. This paper puts forward a new learning model - direct learning model, feedback learning model and historical learning model. The learning architecture of a typical neural network is realized by extracting the user's input, the user's interest obtained by the inference engine, and the processing of the retrieved results. Among them, the personal information database consists of two categories, namely: "personal information" and "keywords" two categories. Keyword database is a search engine that uses keyword database for quasi-static retrieval, accurate matching and stable operation. This technique has been widely recognized and used. The user profile form can record the effective behavior of the user at any time, and can be dynamically modified, its data structure is linear. Table 1 below shows parts of the user personalization information form.

Table 1 User personalized information design structure table

field name	Type	Field length
User_ID	Char	32
User_IP	Number	16
Favorite_Texology	Number	15
Favorite_Value	Number	2
User_Texology	Number	7
Memo	Char	128

User_ID is the primary key in the constructed table. Use the user's IP as the slave keyword; Favorite_Texology uses the level 4 classification structure User_Texology uses the level 3 classification structure where the field value is a decimal number of data bits or a combination code of data bits associated with a particular class [19]. An active search strategy is to use the personalized search tools of search engines. Personalized service goal means that the user does not register or does not want to register on the information keyword User_IP which the user fills in. Personalized customization for customers, access records and personal interest values PISMA, actively provide personalized data to users connected to this system. The personalized message mechanism is to submit the latest query results to the interface agent immediately after the user logs in according to the content that the user is interested in in the recent period.

III. RESEARCH ON CLUSTERING METHODS

At present, there are many researches in this field at home and abroad, and the division of this field is based on two models: level and segment. The method of hierarchical clustering is to conduct cluster search through aggregation or aggregation. The algorithm regards a single data object as a separable cluster, and fuses the clusters with the highest similarity successively until the end of the cluster is reached. The segmented clustering

method searches all clusters at the same time by not constructing hierarchies [20]. In fact, the segmented clustering algorithm first obtains the non-intersection, and then maximizes the connection relationship between clusters through the pre-defined optimization objective function, and then achieves the optimal. This is also the main research content of this project.

When classifying the existing data, it can be divided into several types according to the differences in their classification criteria. The first type is to study multiple clusters of multiple adjacent nodes with the same cluster, which can be divided into two types: one is based on the density of the target, and the other is divided into the same cluster according to the similarity of the target. Two methods are used to cluster multiple data simultaneously. Compared with most existing overlapping cluster-based methods, existing overlapping cluster-based targets can belong to a cluster, among which the most representative overlapping cluster is FuzzyC-means.

Recently, Metaheuristic algorithms have been used to solve data clustering problems. From the point of view of optimization, the clustering problem is modeled as an NP-hard group segmentation problem. This method only needs to find one kind of best cluster, thus reducing the possibility of local extremum easily appearing in the search. GSA is a hyperoptimization method based on Newton's gravity theory, and it is a new global optimization method [21]. In this method, there is a phenomenon of mutual attraction between objects due to the action of their mass and gravity. GSA has a wide range of applications in data clustering, fuzzy identification, classification, load distribution, wind turbine control and power system. Due to the problem of solving mechanism and iterative updating mechanism of the existing gravity search method, The clustering algorithm process is shown in Figure 7 (the image is referenced from A network science-based K-Means-+ clustering method for power systems network equivalence).

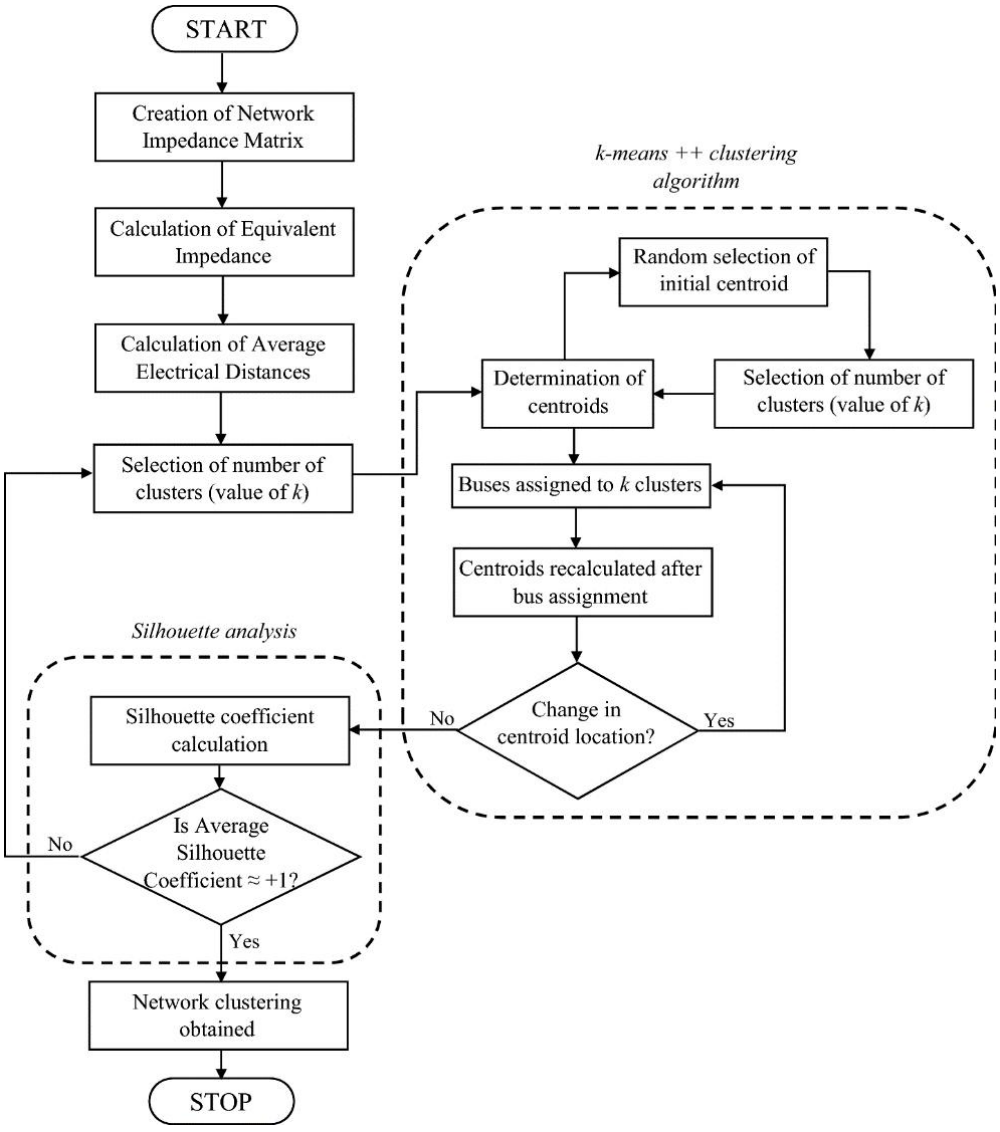

Fig.7 Flow of clustering algorithm

A. Data clustering problem

Data clustering is known as clustering. The data clustering $P=\{P_1,P_2,\cdots,P_n\}$ be a finite set of n data objects R. The goal is to find the best partition $Z=\{Z_1,Z_2,\cdots,Z_E\}, P=\bigcup_{i=1}^{E} Z_i$ of the object P, and for $i\neq j, Z_i\bigcap Z_j\neq\varnothing$, Z_i represents the i cluster of the partition Z. Data in the same class have the greatest similarity, but the difference between them in different classes can be measured by the distance measure. In cluster analysis, an important problem is how to measure the distance between data objects [22]. The similarity objects P_i and P_j is closely related to R, and the common in space R is Euclidean distance. The clustering effect is usually measured as the sum of secondary errors.

$$g(P,Z)=\sum_{l=1}^{E}\sum_{P_j\in Z_i}\|P_j-Y_i\|^2 \tag{1}$$

E represents clusters, and $\|P_j-Y_i\|^2$ represents the data object $P_j\in Z_i$ and cluster i. The cluster center is defined as

$$Y_i=\frac{1}{|Z_i|}\sum_{P_k\in Z_i}P_k \tag{2}$$

$|Z_i|$ represents the cardinality of cluster Z_i, which is the number of data objects in cluster i. It can be divided into two categories: undirected clustering and directed clustering. Undirected clustering is a kind of automatic clustering which does not need to describe the number of clusters [23]. In guided clustering, the sample is classified and the number of categories of the sample is described. Because of the cluster information, our problem is to find the center of E clusters with the goal of minimization, that is, to minimize the sum of the distance between the data object and its cluster center. In this paper, the fitness of a cluster $Z=\{Z_1,Z_2,\cdots,Z_E\}$ on training set P^{Train} is defined as

$$fit(P^{Train},Z)=\frac{1}{|P^{Train}|}\sum_{i=1}^{E}\sum_{P_j^{Train}\in Z_i}\|P_j^{Train}-Y_i\|^2 \tag{3}$$

E is the number of clusters, P^{Train} is the instance set composed of the training set, $|P^{Train}|$ is the number of instances in the training set, and P_j^{Train} is the instance whose subscript is j in the training set.

B. Gravity algorithm GSA

A generalized gravity optimization algorithm based on group optimization is proposed, which can be used to describe the relation between high dimensional objects caused by gravity. The original purpose of GSA theory is to solve a continuous optimal problem, that is, to put an object on a D-dimensional solution set, and then search for its optimal solution [24]. In this algorithm, the location of each Agent represents an alternative solution to this problem. Therefore, each agent can be represented as a vector U_i. If an agent performs better, then its quality will be higher, and because it weighs more, it will be more attractive. During the GSA's operating cycle, each agent continuously adjusts its position U_i, moving toward the position of the best K agent in the population. Consider an E dimensional space with r search agents, where the position of the i as

$$U_i=(u_i^1,\cdots,u_i^e,\cdots,u_i^E), i=1,2,\cdots,r \tag{4}$$

u_i^e represents the position of agent e in i dimensional space. After calculating the fitness of the current population, the mass of agent i can be calculated as

$$h_i(t) = \frac{fit_i(t) - \omega orst(t)}{best(t) - \omega orst(t)} \tag{5}$$

$$S_i(t) = \frac{h_i(t)}{\sum_{j=1}^{r} h_j(t)} \tag{6}$$

$S_i(t)$ and $fit_i(t)$ represent the quality value and fitness value of agent i at time t respectively. $\omega orst(t)$ and $best(t)$ are defined as

$$best(t) = \underset{j\in\{1,2,\cdots,r\}}{Min} fit_j(t) \tag{7}$$

$$\omega orst(t) = \underset{j\in\{1,2,\cdots,r\}}{Max} fit_j(t) \tag{8}$$

The acceleration of agent i is calculated as

$$\rho_i^e(t) = F(t) \sum_{j\in Kbest, j\neq i} rand_j \frac{S_j(t)}{L_{ij}(t) + \varphi}(u_j^e(t) - u_i^e(t)) \tag{9}$$

$rand_j$ represents [0,1]. $L_{ij}(t)$ represents two agents i and j in a E dimensional Euclidean space. φ represents a minimum, avoiding a denominator of 0 in the formula, namely. the Euclidean distance between the two proxies i and j may be 0, but the denominator cannot be 0. $Kbest$ represents the set of the initial K agents and K represents initialized to $K_{initial}$ at the beginning of the algorithm, whose value will decrease over time. $F(t)$ stands for value $F_{initial}$, which also decreases to F_{end} over time, and

$$F(t) = F(F_{initial}, F_{end}, t) \tag{10}$$

The rate update of agent i can be calculated as the sum of the portion of the current rate and its acceleration. The location update of agent i can be calculated as formula (12)

$$\begin{aligned} w_i^e(t+1) &= rand \times w_i^e(t) + \rho_i^e(t) = rand \times w_i^e(t) + \\ & F(t) \sum_{j\in Kbest, j\neq i} rand_j \frac{S_j(t)}{L_{ij}(t) + \varphi}(u_j^e(t) - u_i^e(t)) \end{aligned} \tag{11}$$

$$u_i^e(t+1) = u_i^e(t) + w_i^e(t+1) \tag{12}$$

$rand$ represents uniformly distributed random values between regions [0,1].

IV. SYSTEM INSPECTION

The system designed in this paper can provide users with new timeliness and strong personalized search service in the special field, which has the characteristics of personalized search, initiative and intelligence. Agent Builder is used to design and implement the system, and the method is verified in the laboratory network environment. Experimental results show that the device can work well under simulated conditions. The time for the system to obtain resource data is basically consistent with the analysis results of RIOT algorithm, as shown in Figure 8.

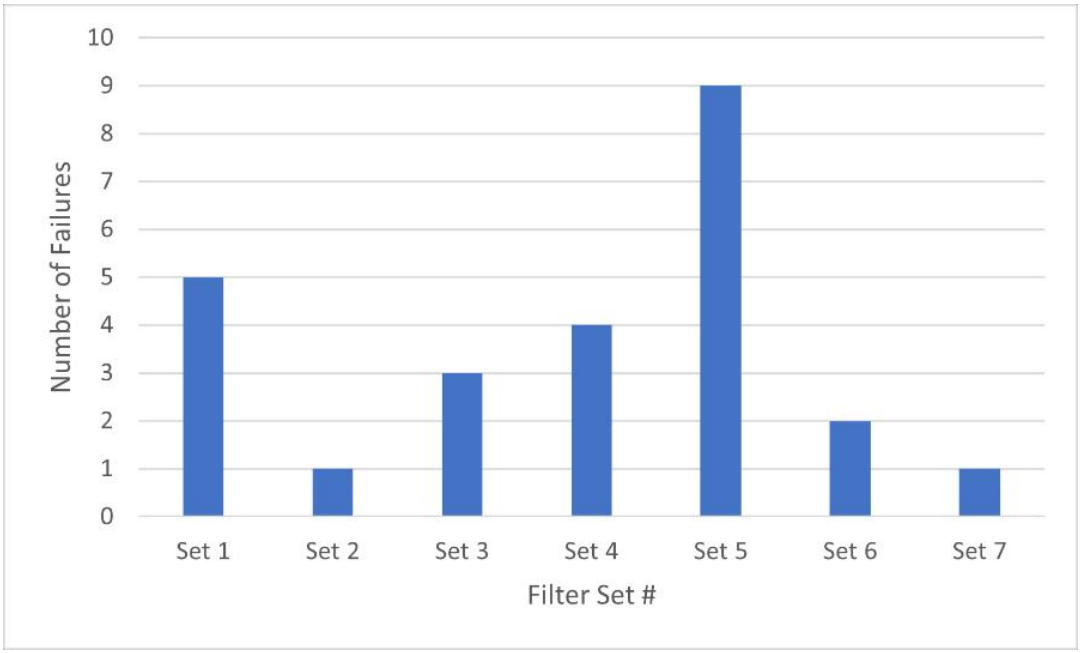

Fig.8 Performance comparison with increasing the number of failures (N=100)

V. CONCLUSION

A difference-based packet coefficient is used instead of the traditional GSA calculation to achieve fast location and rate update. By using the method of clustering differentiation, the original scalar operation can be transformed into clustering operation. The simulation results show that the proposed method has better classification error rate than other similar clustering methods.

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