

## *Retraction*

# **Retracted: Collaborative Intelligent Environment Perception and Mission Control of Scientific Researchers in Semantic Knowledge Framework Based on Complex Theory**

### **Complexity**

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### **References**

- [1] J. Zhao and Y. Li, "Collaborative Intelligent Environment Perception and Mission Control of Scientific Researchers in Semantic Knowledge Framework Based on Complex Theory," *Complexity*, vol. 2020, Article ID 6637375, 11 pages, 2020.

## Research Article

# Collaborative Intelligent Environment Perception and Mission Control of Scientific Researchers in Semantic Knowledge Framework Based on Complex Theory

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In the traditional scientific research and production activities, due to the lack of sufficient communication and communication between researchers, the phenomenon of waste of scientific research resources occurs from time to time, which hinders the efficiency of scientific research output. Based on the design principle of the semantic knowledge framework, this paper puts forward the definition of ontology and semantic relationship of the collaborative system of scientific researchers. In this paper, a framework of collaborative semantic knowledge among researchers is established through decentralized semantic information exchange architecture. In this article, the simulation is verified by experiments and compared with other exchange architectures. The results of the experiment confirmed the semantic information exchange architecture based on semantic knowledge proposed in this paper is 10.39% faster than the traditional centralized method in terms of data volume; the construction speed under the data node perspective is 12.84% higher than that of the traditional centralized construction method; the subject query speed is 36.84% higher than that of the traditional centralization method; the predicate query speed is 31.58% higher than that of the traditional centralization method. The experimental results confirm that the semantic information exchange architecture based on the semantic knowledge framework is feasible, and it has excellent performance in terms of construction speed and query speed. Under the background that researchers rely more and more on collaborative technology to interact with other members, this paper has a certain reference value and exploration value and proposes a new idea of group collaboration system under the framework of semantic knowledge.

## 1. Introduction

With the advent of the information age, especially the development of web technology and computer-supported collaborative technology, the academic environment of modern science and technology has changed. The interdisciplinary and interpenetration between disciplines is a remarkable feature of modern science and also the main direction of scientific research. Due to the complexity and specialization of scientific research tasks, it is more difficult for researchers to complete scientific research tasks relying on personal knowledge reserves [1]. The tasks in the field of scientific research should be based on team cooperation. As a

high-efficiency organization form of scientific research, collaborative research will become an effective way to improve scientific research efficiency, reduce research costs, strengthen academic exchanges, and stimulate academic innovation. At the same time, it hinders the rapid development of information for users. As a special kind of users, researchers' information behavior is different from other information users. The essence of scientific research personnel is not to obtain a large amount of information but to obtain information that can solve problems. In traditional scientific research and production activities, due to the lack of sufficient communication and communication between researchers, the phenomenon of waste of scientific research

resources occurs from time to time, which hinders the efficiency of scientific research output. In terms of an isolated scientific research environment, collaborative scientific research cooperation has become necessary [2].

Allen et al.'s research shows that collaborative research has become the pillar of knowledge production in many scientific fields and has been promoted as a method to improve the quality of scientific research, resource utilization, and influence. But he did not do more in-depth research, leading to the conclusion is not comprehensive [3]. In terms of the motivation of collaborative research, Botsford et al. analyzed the difference between the experimental research and the theoretical research and concluded that the difference of professional division was the main factor that promoted the collaborative research. In the process of research projects, it is easier to obtain knowledge and experience of new partners than to master new knowledge by themselves. Knowledge resources obtained from collaborative partners can improve scientific research efficiency and output. Due to the lack of comparison objects selected in the research project, the conclusion cannot be used as a reference basis [4]. At the same time, scholars have also noticed the impact of scenario factors on collaborative research and development. Berbegal's impact on collaborative research and cooperation shows that regional, cultural, economic, and political factors are the main factors affecting collaborative research, while the degree of collaboration decreases with the increase of space and geography among research partners. However, he did not list the detailed data, resulting in his research conclusion is not rigorous [5]. In addition, transportation and communication technology is also one of the factors affecting collaborative research. The convenient traffic conditions and convenient communication technology eliminate the collaborative obstacles brought by the region and also greatly reduce the cost of scientific research, which provides favorable conditions for the collaborative cooperation and academic exchange between scientific research studies.

This research breaks through the pure theory behavior discussion, based on the theoretical analysis, supplemented by the investigation and analysis of practical application, combines the theory and practice, focuses on the collaborative information behavior of users in the collaborative research environment, and takes the collaborative research environment as the background, based on the semantic knowledge framework, the language of the environment perception system, the collaborative architecture, and the knowledge framework of the researchers. Finally, the feasibility of the semantic knowledge framework is verified by simulation experiments.

## 2. Theoretical Basis of Group Collaboration Architecture, Intelligent Environment Awareness, and Semantic Knowledge Framework

### 2.1. Intelligent Environment Awareness

**2.1.1. Convolution Neural Network.** CNN is an important model in-depth algorithm. It is a nonlinear and adaptive mathematical model for processing information, and it

consists of a large number of independent computing nodes. It is suitable for processing data with grid structure (such as image composed of two-dimensional pixel grid). CNN structure is similar to ANN, which is mainly divided into three parts: the input layer receives the signals and data outside the model and receives the original image information as input in CNN; the hidden layer performs nonlinear mapping on the input data to form the characteristics of different levels of data; and the output layer outputs discrete or continuous data processing results [6, 7]. Based on ANN, CNN introduces sparse connection, weight sharing, and downsampling technology to realize hierarchical processing of visual information.

As shown in Figure 1, CNN model has a variety of structures, including convolution layer, downsampling layer, and activation layer. Convolution layer, pooling layer, and activation layer are three basic structures to form function modules to realize feature coding and nonlinear mapping. Multiple functional modules form the deep model to realize the abstract expression of features. Finally, class labels and probability are output through full connection layer and loss layer [8, 9].

(1) *Convolution and Activation.* Convolution operation can be regarded as a linear operation process of weighted sum of two-dimensional images. At this time, the weight matrix used is called convolution kernel. Unlike the dense connection of neurons in ANN, the convolution kernel of CNN is associated with a certain region in the two-dimensional image, and the value after weighted sum is activated as the corresponding pixel value of the new feature map [10]. The convolution operation in CNN is as follows:

$$x_j^l = f \left( \sum_{i \in M_i} x_i^{l-1} * k_{ij}^l + b_j^l \right), \quad (1)$$

where  $f$  is the layer index;  $x$  is the feature graph, which is a two-dimensional matrix;  $i$  and  $j$  represent the input and output feature map indexes, respectively. Specifically,  $x_j^l$  is the  $j$ -th output characteristic graph of this layer;  $x_i^{l-1} * k_{ij}^l$  is the convolution operation of the output characteristic graph of the upper layer through kernel  $k_{ij}^l$ ;  $i \in M_i$  is the traversal operation of all input characteristic graph;  $*$  is the convolution operation;  $b_j^l$  is the offset direction; and  $f$  is the activation function.

The main function of the activation layer is to realize the nonlinear transformation of CNN. Activation functions have many variations, such as sigmoid function, tanh function, and relu function. Currently, relu activation function is commonly used, which has the advantages of stable error propagation for different input sizes and avoiding gradient explosion or dispersion. Moreover, the activation function has zero response to negative input and can realize the sparse connection of the network [11].

(2) *Pooling.* Pooling layer is also known as the lower sampling layer, and the common ones are Max pooling, average pooling, and min pooling. The pooling layer can reduce the spatial resolution of the feature map, so as to reduce the

network scale, accelerate the network training, reduce the overfitting, and make the features have strong translation and scaling invariance for different inputs [12]. The general expression of pooling operation is as follows:

$$x_j^l = f(\beta_j^l \text{down}(x_j^{l-1}) + b_j^l). \quad (2)$$

Down( $\cdot$ ) is the partition calculation operation of the feature graph, such as dividing the feature graph into  $n \times n$  grids and calculating the sum, maximum value, and minimum value of each part.  $\beta_j^l$  is the weight parameter of grid elements; 1 is taken for maximum pooling;  $1/S$  is taken for average pooling ( $s = w \times h$ , where  $w$  and  $h$  are pool kernel sizes, respectively); and  $f$  is the activation function.

**2.1.2. MobileNet.** MobileNet is a lightweight CNN model designed for embedded hardware platform. By introducing a depth separable convolution layer, the standard convolution is decomposed into a combination of depth convolution which only extracts features from a single channel and point convolution that fuses all channel information, thus greatly reducing the amount of parameters and realizing model acceleration [13]. The number of input channels is  $n_i$ , and the size of the input characteristic graph is  $w_i$  and  $h_i$ . The corresponding output channel number and characteristic layer sizes are  $n_{i+1}$ , and  $w_{i+1}$  and  $h_{i+1}$ , respectively. If the size of the convolution kernel is  $k_i \times k_i \times n_i$ , the number of standard convolution multiplication operations is given by

$$k_i \times k_i \times n_i \times n_{i+1} \times h_i \times w_i. \quad (3)$$

Deep convolution is a special case in which the number of blocks is equal to the number of channels in block convolution:

$$k_i \times k_i \times n_i \times h_i \times w_i. \quad (4)$$

Deep convolution is independent in different channels, so there is a problem that information does not flow between channels. In MobileNet, different channel information is combined in the form of point convolution between channels:

$$1 \times 1 \times n_i \times n_{i+1} \times h_i \times w_i. \quad (5)$$

When the standard convolution is replaced by separable convolution, the compression ratio of the model is given by

$$\frac{k_i \times k_i \times n_i \times h_i \times w_i + n_i \times n_{i+1} \times h_i \times w_i}{k_i \times k_i \times n_i \times n_{i+1} \times h_i \times w_i} = \frac{1}{n_{i+1}} + \frac{1}{k_i^2}. \quad (6)$$

Generally, the convolution kernel size of CNN structure is  $3 \times 3$ , and the number of output characteristic layers  $n_{i+1}$  is often large. According to formula (6), when the standard convolution operation is replaced by separable convolution, the compression ratio of model parameters and multiplication operation is  $1/8 \sim 1/9$ .

The design of the MobileNet grid structure is very similar to VGGNet. The spatial resolution of the feature map decreases monotonously, and the number of channels increases monotonously. When the resolution is reduced by

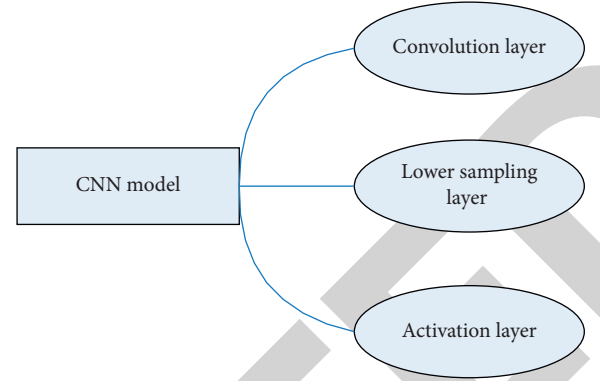


FIGURE 1: CNN mode structure.

half, the number of feature layers is doubled. The differences are as follows:

- (1) MobileNet replaces the standard convolution with deep separable convolution in VGGNet
- (2) MobileNet does not set the pooling layer but reduces the spatial resolution of the feature map by the convolution step size of 2
- (3) MobileNet replaces the two full link layers of VGGNet  $4096 \times 4096$  and  $4096 \times 1000$  with  $7 \times 7$  average pooling layer, realizing further compression of the model [14]

## 2.2. Principle Design of Semantic Knowledge Framework

**2.2.1. Semantic Knowledge Framework.** Semantic knowledge framework can be considered as an analysis method in philosophy. The analysis method has one basic element and two cores. The basic element is concept. The first core is the relationship between concepts. The second core is to realize reasoning function through the relationship between concepts. Second, the semantic knowledge framework can be a form of computer knowledge storage and representation and concept. Finally, the semantic knowledge framework can also be used for knowledge processing, such as identification, reasoning, query, knowledge consistency maintenance, scenario calculus, and planning so as to achieve knowledge fusion, knowledge extraction, knowledge discovery, natural language generation, and other functions [15, 16].

Semantic knowledge framework can be used to describe any complex relationship between anything, but this description is based on a series of basic semantic relations. Basic semantic relations are the basic elements of complex semantic knowledge framework. The basic semantic relations are various and flexible. As shown in Figure 2, here are some commonly used relations.

(1) *Semantic Relation.* Semantic relation generally describes the generic relationship between things, including IS-A, A-Kind-Of, and Instance-Of.

IS-A means that one thing is an instance of another. It can be expressed as “. . . It’s an example of.” For example, if a geological researcher is regarded as a class and a geological



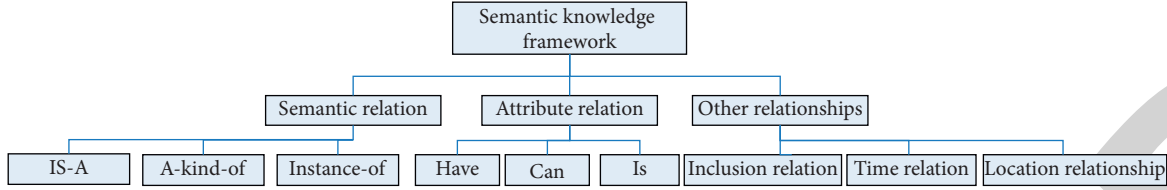


FIGURE 2: Framework diagram of the semantic knowledge framework.

exploration technician is a member of the class, then the geological exploration technician is an example of a geological researcher.

A-Kind-Of means that one thing is a type of another “It’s a kind of . . .” AKO represents a larger range than IS-A. It usually does not represent the relationship between specific individuals but represents the relationship between classes. AKO is generally used to establish the relationship between subclasses and superclasses. For example, geological researchers are a subclass, scientific researchers are a parent class, and the semantic relationship between geological researchers and researchers can be represented by AKO.

The Instance-Of relation is the opposite of IS-A relation, which means that one instance of something is another.

(2) *Attribute Relation.* Attribute relationship usually refers to the relationship between things and their attributes. Any object in any class has one or more properties, and each property corresponds to a value. Therefore, there will be a corresponding combination of properties and values. The commonly used attribute relation is the predicate or verb of a sentence. For example, Have, Can, and Is.

Have means that things have a certain attribute relationship, which is expressed as “have.”

Can means the relationship between certain attributes of things, which can be expressed as “can” or “will.”

Is has no specific representation and can be understood as a variety of relationships. If something has multiple relationships with other things or attributes, they can be connected through is.

(3) *Other Relationships.* The relationship in the real world is very complex. In addition to the above semantic relations and attribute relations, there are many kinds of relationships between things and between things and attributes. The other main relationships are inclusion relationship, time relationship, location relationship, and similarity relationship [17].

The inclusion relation represents the relationship between the whole and the part. The difference between inclusion relation and attribute relation is that inclusion relation can be inherited and part of it belongs to whole, but it has all attributes of whole. Inclusion relationships can be described as Part-of or Composed-of.

The time relation represents the sequence of events in time. For example, Before means that an event must occur before a specific event occurs; At means that an event occurs at the same time as another event; and After means that an event can only occur after a specific event occurs.

Positional relations represent the relationship between things in space. If the position of one thing is in front of another, it can be represented by Location-front; if something is behind another, it can be expressed by Location-behind.

2.2.2. *Knowledge Graph.* Knowledge map is actually a semantic network, which can form reasoning semantic knowledge network from the connection of different semantic entities according to the change (relationship). The representation form is a graphical structure. In fact, the construction process of knowledge map includes the following: integrating the form of semantic knowledge and data cleaning form into heterogeneous data sources, establishing the relationship model through relation extraction, and finally establishing a directed graph structure database, which can reflect the semantic relationship between entities [18]. The query of the knowledge map is based on visual query. The knowledge obtained through input information is not a large number of web pages obtained by string matching, but the structured knowledge that users really need.

### 2.3. Swarm Intelligence Algorithm

#### 2.3.1. Cuckoo Search Algorithm

(1) *Lévy Flight.* Lévy distribution is a kind of continuous probability distribution. The letters  $\delta$ ,  $\alpha$ ,  $\mu$ , and  $\beta$  represent the scale, characteristic index, displacement, and skewness parameters, respectively:

$$\begin{aligned}
 P_{\alpha,\beta}(\kappa; \mu, \sigma) &= F\{P_{\alpha,\beta}(x; \mu, \sigma)\} = \int_{-\infty}^{\infty} dx e^{ikx} P_{\alpha,\beta}(x; \mu, \sigma) \\
 &= \exp\left[iuk - \sigma^\alpha |k|^\alpha \left(1 - i\beta \frac{k}{|k|} \bar{w}(k, \alpha)\right)\right], \\
 \bar{w}(k, \alpha) &= \begin{cases} \tan \frac{\pi\alpha}{2}, & \text{if } \alpha \neq 1, 0 < \alpha < 2, \\ -\frac{2}{\pi} \ln|k|, & \text{if } \alpha = 1. \end{cases}
 \end{aligned} \tag{7}$$

The probability density function of the Lévy distribution is related to  $\alpha$  characteristic index and  $\beta$  skewness parameter. When  $\alpha$  and  $\beta$  take different values, they can be expressed by different distribution functions (such as Gaussian distribution, Cauchy distribution, and Lévy distribution).

When  $\alpha = 2$ , the following Gaussian distribution function is used:

$$p_2(x) = \frac{1}{\sqrt{4\pi}} \exp\left(-\frac{x^2}{4}\right). \quad (8)$$

When  $\alpha = 1$  and  $\beta = 0$ , it is expressed by the Cauchy distribution function:

$$p_{1,0}(x) = \frac{1}{\pi(1+x^2)}. \quad (9)$$

When  $\alpha = 1/2$  and  $\beta = 1$ , it is expressed by the Lévy distribution function:

$$p_{1/2,1}(x) = \begin{cases} \frac{1}{\sqrt{2\pi}} x^{-(3/2)} \exp\left(-\frac{1}{2x}\right), & x \geq 0, \\ 0, & x < 0. \end{cases} \quad (10)$$

The waiting time of Lévy flight jump length obeys the power law distribution function:

$$\text{Lévy}(\beta) \sim \mu = t^{-1-\beta}, \quad 0 < \beta \leq 2. \quad (11)$$

There are two main elements in Lévy flight, which are moving direction and jumping step size  $s$ . In Mantegana's law, the definition of step length  $s$  is as follows:

$$s = \frac{\mu \times \varepsilon}{|\nu|^{1/\beta}}, \quad (12)$$

where  $\mu$  and  $\nu$  obey the standard normal distribution,  $\beta = 1.5$ .

$$\varepsilon = \left( \frac{\Gamma(1+\beta) \times \sin(\pi \times \beta/2)}{\Gamma((1+\beta)/2) \times \beta \times 2^{(\beta-1)/2}} \right)^{1/\beta}. \quad (13)$$

**3.2.2. Clustering Algorithm.** In K-means algorithm, the sum of squares of errors is used as the partition criterion:

$$E(C) = \sum_{i=1}^K \sum_{x_j \in C_i} \|x_j - \mu_i\|^2. \quad (14)$$

K-medoids clustering algorithm uses the actual data points as the clustering center and takes the absolute error as the division:

$$E = \sum_{j=1}^k \sum_{x \in N_j} |x - C_j|. \quad (15)$$

**3.2.3. Fast Search Algorithm of Density Peak.** For each data point  $I$ , the DPC algorithm needs to calculate its local density  $\rho_i$  and its distance  $\delta_i$ . When the set of data points is large, the local density  $\rho_i$  of data point  $i$  is calculated by the following formula:

$$\rho_i = \sum \chi(d_{ij} - d_c), \quad (16)$$

where  $X(x)$  is given by

$$\chi(x) = \begin{cases} 1, & x < 0, \\ 0, & x > 0. \end{cases} \quad (17)$$

When the set of data points is small, the local density of data points is calculated by the exponential kernel:

$$\rho_i = \sum_j e^{-(d_{ij}/d_c)^2}. \quad (18)$$

The formula for calculating the distance of data point  $I$  is as follows:

$$\delta_i = \min_{j: \rho_j > \rho_i} (d_{ij}). \quad (19)$$

For local density maximum data point  $i$ , the distance formula is as follows:

$$\delta_i = \max_j (d_{ij}). \quad (20)$$

### 3. Design of Simulation Experiment

#### 3.1. Group Collaboration Architecture

- (1) Introduction: the design of group architecture is related to the level and function division of each unit in the system and is the basis of each unit structure design [19]. The structure of the unit determines the assignment of tasks, the content of information flow, and the specific stage of task execution. The design of group architecture should follow the following principles:

- (a) Clear hierarchy: hierarchical relationship includes two parts: group level and internal operation level. A clear hierarchical relationship helps to plan and integrate each unit into the system independently; the hierarchical structure of internal functional units is conducive to the standardization and design of the system and is convenient to adjust and expand the system [20, 21].
- (b) Reasonable function distribution: it is necessary to make logical planning for the functions of different levels in the system, so as to avoid some functions being too complex and others relatively single. Otherwise, it will not only affect the overall performance of the system but also reduce the execution efficiency due to the large amount of data processing, leading to the paralysis of some system units.
- (c) Efficient information transmission: the content and form of information transmission between units and operation modules should be fully considered in the design of system structure. In the unit, the standardization of information and the design of the summary process are of great significance to improve the execution efficiency and reduce the cost of the system.

- (2) As shown in Figure 3, the organizational forms of group collaboration can be divided into centralized, decentralized, and distributed.

**3.1.1. Centralized Control Structure System.** The system is controlled by a main control unit, which is a top-down hierarchical control structure for planning and decision-making. The number and complexity of the main control units determine the time required to respond to the system and the quality of decision-making behavior [22]. The main control unit is responsible for the dynamic allocation of tasks and the potential planning of resources and coordinates the competition and cooperation among various posts. The system is easy to manage, control, and program.

**3.1.2. Decentralized Control Structure System.** Each individual in the system has an equal relationship, has a high degree of intelligent autonomy, independently processes information, design, and decision-making, performs its own tasks, and communicates with other units to coordinate their behavior without a central control unit [23]. The structure has good flexibility, scalability, and reliability, but the communication requirements are high and the efficiency of multilateral negotiation is low. Therefore, it is difficult or unable to guarantee the realization of the global goal.

**3.1.3. Distributed Control Structure System.** This structure is the product of the combination of decentralized horizontal interaction and centralized vertical control. It is composed of a group of independent, completely equal, no logical master-slave relationship and self-discipline. According to the predefined protocol, according to the system goal, state, and its own state, ability, resources, and knowledge, each unit uses the communication network to consult and negotiate with each other to determine their respective tasks, coordinate their own activities, realize the sharing of resources, knowledge, information, and functions, and cooperate to complete common tasks to achieve the overall goal. In this kind of system, each unit is independent of each other in structure and function, and they all communicate with each other through the network in the same way, with good encapsulation, so the system has good fault tolerance, openness, and scalability [24, 25].

**3.2. Experimental Dataset.** In this paper, we build a decentralized system of 6 nodes in win10 environment. The protocol includes Hypertext Transfer Protocol and Peer-to-Peer. The ArchiveHub dataset is used in the experiment. The size of the dataset is 72 m, the quantity of the substance is 107219, the number of subjects is 51385, the number of unique predicates is 143, the quantity of unique objects is 104389, and the number of triples is 432142. In this article, the data collection is carved up into six parts, named X1~X6, construct a respective knowledge map for each data collection and save it in six nodes.

Table 1 shows the essential information of the six datasets. In the subsequent comparative experiments, the trend of construction time and query time is related to the trend of the number of unique entities. It can more directly reflect the series ring in the process of physical connection building the global knowledge map, and a copy of the selected node information is copied in XL~X6.

**3.3. Verification Test.** Building module verification experiment: Several entity modules are randomly selected for construction. In this process, we can explore and verify the construction effect of the semantic information exchange system by viewing the connection period between the entity modules. With physical resources self3810 as an example, self3810 points to dataset X2 (port number 8002) in the connection information table of the node where dataset X1 (port number is 8001) is located and in the connection information table of the node where dataset X2 (port number 8002) points to dataset X3 (port number 8003). Dataset X3 (connection information table with port number 80031) points to dataset X1 (port number 8001). From the above results, the entity resource self3810 forms a link cycle in the three nodes of the system, and the link cycle trend is as follows: the next largest node is the next node pointed to by the current node.

## 4. Comparison of Test Results of Different Methods

This article mainly conducts experiments from two aspects: the construction speed of the semantic knowledge framework and the query speed.

**4.1. Construction Rate Comparison (Data Volume Perspective).** The contrast experiment design of construction rate is compared with the centralized construction system from two dimensions of data size and node number size.

As shown in Figure 4 and Table 2, from the perspective of data volume, the construction rate of other methods and the semantic knowledge framework system proposed in this paper is compared. Taking three nodes as a group, the amount of data gradually increases to observe the respective performance of the centralized system and decentralized system. It can be concluded from the figure that

- (1) With the increase of data volume, the construction time of both centralized and decentralized knowledge maps will show a slow upward trend. A very important part of the construction process of the knowledge map is the data transmission and connection, and the construction time is mainly increased in the data transmission connection part. Therefore, because of the growth of data volume, the construction time of both the centralized system and the decentralized system will increase correspondingly.

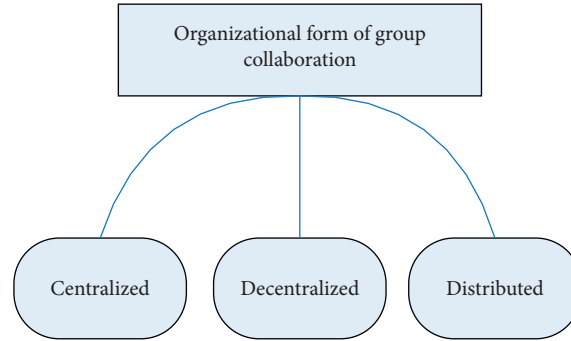


FIGURE 3: Organization form chart of group collaboration.

TABLE 1: Basic information of experimental data collection.

Data collection	File size	Quantity of unique substance	Quantity of triplet	Quantity of unique subjects	Unique predicate quantity
X1	5.8	16875	29746	6971	14082
X2	6.9	21538	39910	9285	13369
X3	9.4	20364	54189	2614	20871
X4	15.7	29483	79852	4536	27259
X5	16.1	40576	101987	12857	30364
X6	18.9	43295	123948	14921	30428

(2) According to Figure 1, when the size of the dataset is small, the construction speed of the proposed semantic knowledge framework system is lower than that of the traditional construction method. But, with the increase of datasets, the semantic knowledge framework system gradually shows its advantages. The reason is that the system constructed by the traditional method needs to transmit all datasets, but in order to protect the information of each node, the system only transmits the unique entity set. The reason why the rate of early construction of the system proposed in this paper is slower than that of the traditional method is that the empty node needs to send the generated information back to each node, which takes a lot of time.

#### 4.2. Construction Rate Comparison (Data Node Perspective).

As shown in Table 3 and Figure 5, this paper compares the construction rate of traditional methods with that of the semantic knowledge framework system proposed in this paper. With the increasing number of nodes, the performance of the centralized system and decentralized system is observed. It can be concluded from the figure that

- (1) From the overall trend, with the increase in the number of nodes, the construction time of both centralized and decentralized semantic knowledge framework will show an upward trend. Since the construction of the semantic knowledge framework requires the connection between nodes and data transmission, with the increase in the number of nodes, the construction time of both centralized and decentralized systems will increase correspondingly.
- (2) As shown in Figure 5, we can see that the construction rate of the semantic information exchange

architecture in this paper is lower than that of the traditional semantic information exchange architecture in the case of a small number of nodes. However, with the increasing number of nodes, the construction speed of the decentralized semantic information exchange architecture proposed in this paper is gradually higher than that of the traditional semantic information exchange architecture construction. The reason is that the traditional method of transmitting information only needs to protect part of the dataset. The reason for the slow construction speed of the system proposed in this paper is that the empty node needs to return the generated connection information to each node, which takes part of the time.

#### 4.3. Comparison of the Number of Subject-Predicate Word

*Number Queries.* As shown in Table 4 and Figure 6, the query time of the two types of systems under different subjects is shown.

As shown in Table 5 and Figure 7, the query time of the two systems under different predicates is shown. It can be concluded from Figure 4 that

- (1) With the increasing number of subject-predicate words, the query time will also increase. This is because the number of query levels in the query mode is determined by the number of subject-predicate words. If the number of subject-predicate words increases, the number of query connection levels will increase.
- (2) In terms of the same subject or predicate word number, the query speed of the decentralized query mode is faster than that of the centralized query mode. This is because in the decentralized query



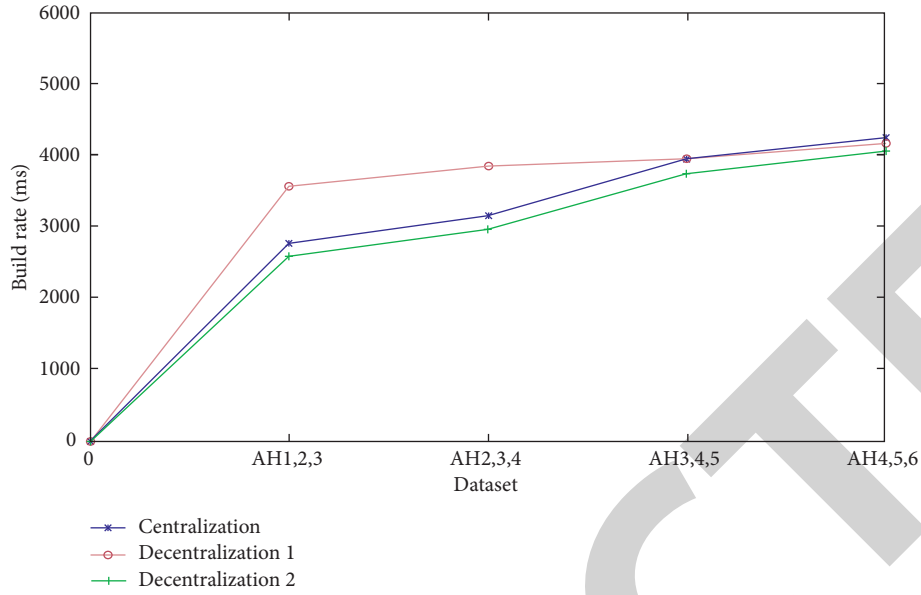


FIGURE 4: Rate comparison (data volume).

TABLE 2: Rate comparison (data volume).

	AH1,2,3	AH2,3,4	AH3,4,5	AH4,5,6
Decentralized	2784	3129	3926	4089
Centralized 1	3632	3775	3851	3967
Centralized 2	2564	2941	3472	3845

TABLE 3: Rate comparison (data node).

Build time	1	2	3	4	5
Decentralized	516	524	1418	1895	2654
Centralized 1	1136	957	1594	2015	1720
Centralized 2	1306	1274	1453	1801	1651

TABLE 4: Query rate comparison (subject).

Query time	1	2	3	4
Decentralized	58	102	167	194
Centralized 1	103	181	253	328
Centralized 2	109	196	261	341

mode, queries are parallel, and the connection between tables is based on the connection information part of each node dataset; in the centralized system, the table join during query is the self-join of the whole large dataset.

- (3) In terms of the overall trend, the increase of query time in the decentralized query mode is gradually decreasing, while that in the centralized query mode is unchanged. This shows that with the increase of subject-predicate words, the advantage of the decentralized query mode will become more and

more obvious. This is because each table join of a centralized query queries the semantic knowledge framework, so the increase is not changed, and each connection of the distributed query is based on the connection information part of each node dataset. In summary, the performance of decentralized semantic information exchange query mode based on the semantic knowledge framework of group collaborative intelligent environment and mission control is better than that of the traditional centralized query mode.

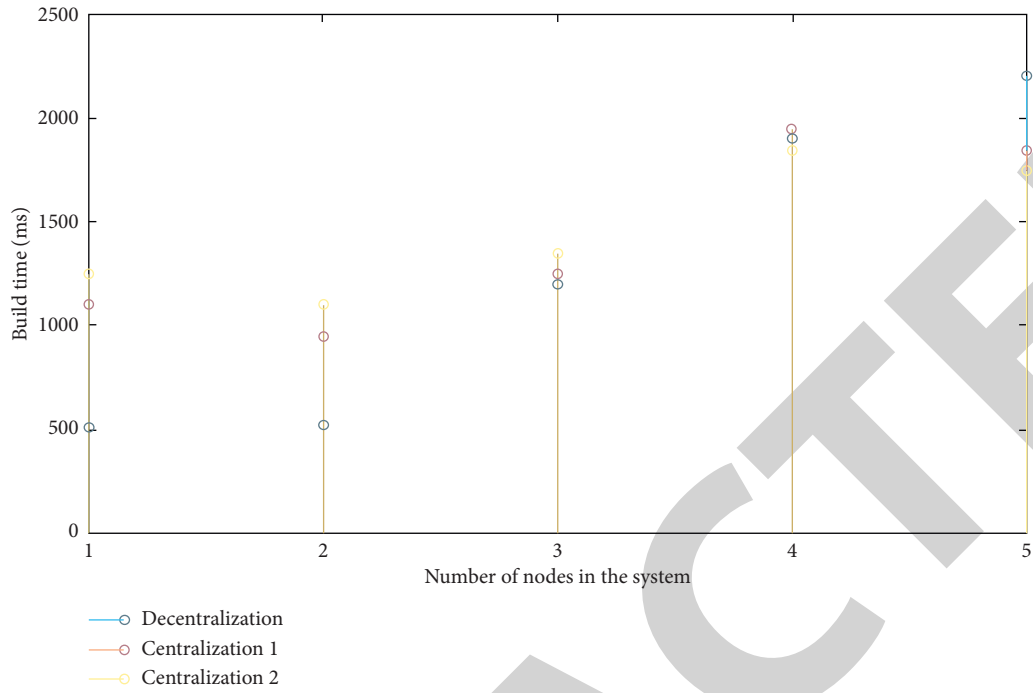


FIGURE 5: Rate comparison (data node).

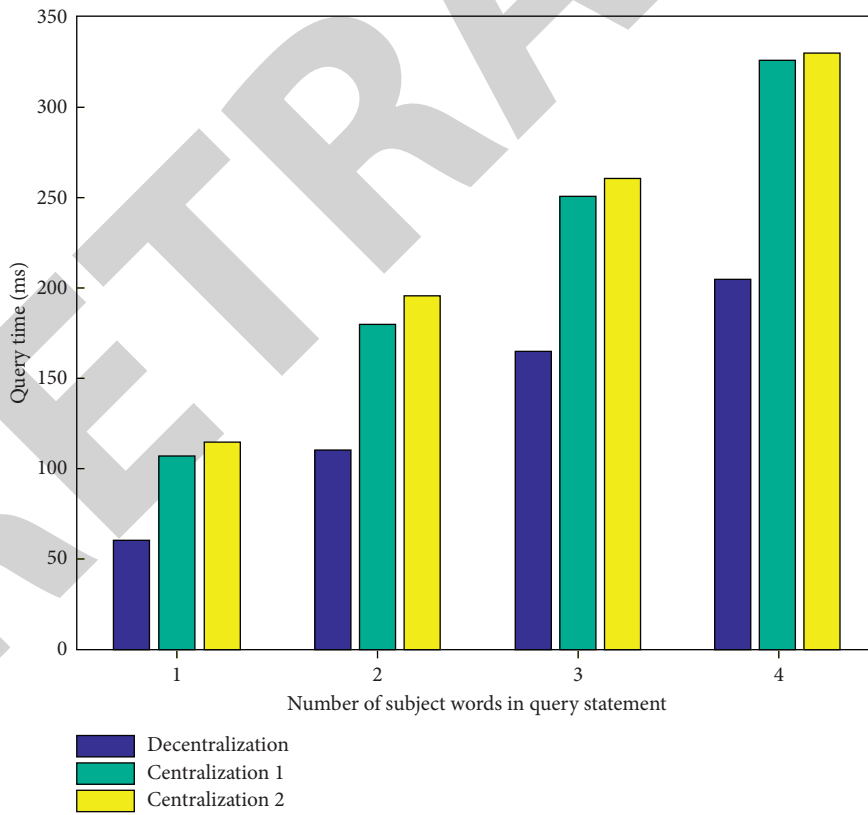


FIGURE 6: Query rate comparison (subject).

TABLE 5: Query rate comparison (predicate).

Query time	1	2	3	4
Decentralized	51	105	154	187
Centralized 1	101	194	246	337
Centralized 2	107	203	259	352

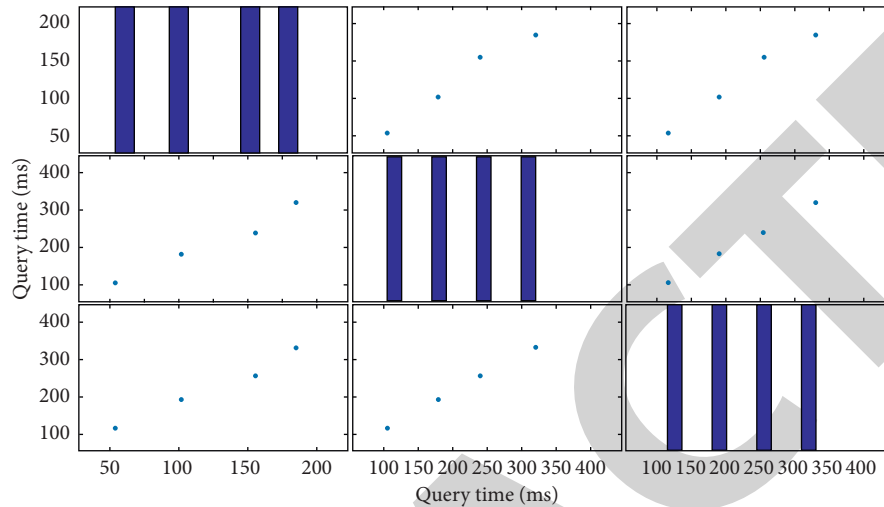


FIGURE 7: Query rate comparison (predicate).

## 5. Conclusions

The main research content of this paper is based on the semantic knowledge framework of collaborative intelligent environment perception and mission control. In this paper, the concept of environmental awareness system, group collaboration, and semantic knowledge framework is introduced and analyzed in detail. In this paper, through the establishment of temporary space-time nodes with the same level as other nodes in the network, the interconnection and interaction between nodes can be realized, and the self-determination mechanism can realize the knowledge connection between nodes on the basis of maintaining their own knowledge. On the basis of the interaction mechanism of Unicom, we design and implement the decentralized Iterative Incremental Construction Scheme of the semantic knowledge framework and the corresponding query mode. On the premise that knowledge is not acquired, the connection construction and query between nodes are realized.

Experiments show that the semantic information exchange system structure constructed in this paper is feasible and effective. The integrity of the global semantic knowledge framework and the centralized semantic knowledge framework is the same, and the global semantic knowledge framework constructed in this paper has better performance than the middle school system in the construction speed and query rate.

At present, there are few research studies on the semantic knowledge framework, and there are still many deficiencies in this paper due to the limitation of time, specialty, and technical level, for example, lack of rule layer, only realize the sharing of data rather than rules; need to further improve the

algorithm to improve the query efficiency; and do not discuss the specific factors and influence coefficient of collaborative information in the collaborative research environment. The above shortcomings will be the next step of this project.

## Data Availability

No data were used to support this study.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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