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*Research Article*

# A Semantic Model of Internet of Things for Intelligent Translation and Learning

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There were a lot of multisource data and heterogeneous devices in the intelligent system of the Internet of things, and the existing methods were difficult to meet the service needs of users for intelligent entities. Therefore, this paper proposed a semantic model construction method of the Internet of things based on intelligent translation and learning. Firstly, on the basis of summarizing the relevant theories of semantic Internet of things, this paper analyzed the semantic data and its characteristics, and expounded the common ontology matching methods. Secondly, according to the characteristics of service ontology and user ontology in intelligent Internet of things system, a method of matching two different ontologies based on string and semantic relationship was proposed, and the cyclic neural network method was used to organically integrate the semantic data of ontology. Finally, in order to realize the perception and representation of the context information of the Internet of things, a semantic model of the Internet of things based on intelligent translation and learning was constructed. Through experimental comparative analysis, the results showed that compared with the traditional methods based on semantic similarity and semantic distance, the semantic model of the Internet of things proposed in this paper had better performance in accuracy and recall, and can achieve better application effect of the Internet of things system. The model proposed in this paper will provide a theoretical reference for further exploring the sharing and service of heterogeneous devices and data in the intelligent Internet of things system.

## 1. Introduction

As the application extension of the Internet, the Internet of things is a product driven by a variety of technologies such as computer and communication. Internet of things is a network that connects various sensing devices and intelligent objects through the Internet. It uses intelligent devices to perceive the objective world and realize the interconnection of different objects. The nodes of the Internet of things use the data perception method to identify the physical world, use the network to establish the information transmission channel, and realize the interactive operation between people and things through the calculation and processing of a large amount of data, so as to effectively control and manage the objective world [1]. With the continuous development of electronic and communication technology, intelligent application system based on Internet of things has also developed rapidly. However, due to the multisource and heterogeneity of data perception of intelligent devices related to the Internet of things, there are many problems in information interaction, logical reasoning, and knowledge representation of different intelligent platforms, which affect the normal use of the intelligent system of the Internet of things. For example, in the smart home IOT system, not only there are multisource data generated by indoor lighting, television, light intensity sensors, temperature sensors, and other equipment, but also they are related to relevant IOT systems such as intelligent medical system, intelligent security system, and intelligent power system. These different systems also have differences in equipment connection mode, data transmission format, and so on. Therefore, in view of the heterogeneity and multisource of data perception of the Internet of things, how to interconnect and integrate different data has attracted extensive attention of relevant scholars [2].

Different from other networks, the application of Internet of things system involves many fields and requires different types of intelligent equipment. In addition to general sensors, it also includes intelligent instruments, intelligent appliances, and machinery [3]. In the Internet of things system, not only new nodes can be added at any time, but also new data types or protocols that need to be processed or supported by the system can appear at any time. Therefore, the Internet of things is a dynamic system. In addition, the Internet of things system is limited by space-time and other conditions, in which the impact of intelligent devices on the system is diverse and complex, which adds difficulties to the semantic modeling of the Internet of things system [4]. Although properly adding semantic information to the Internet of things system can solve the problem of data heterogeneity, it cannot solve the problems of interaction mode and behavior response of intelligent objects. In order to realize the semantic interoperability and data interaction between heterogeneous systems of the Internet of things, this paper proposed a semantic model construction method of the Internet of things based on intelligent translation and learning. By summarizing the data characteristics and semantic collaboration methods of semantic Internet of things, this paper used ontology matching technology to describe the semantics of intelligent devices and interaction behavior, and constructed the semantic translation and learning model of Internet of things by using cyclic neural network method. This paper will provide theoretical support for the realization of intelligent interaction and operation of Internet of things.

## 2. Related Works

In order to solve the problem of interoperability and collaboration between heterogeneous devices and cross systems in the application field of Internet of things, some researchers propose to realize semantic unification between heterogeneous devices through sharing environment and service components based on semantic web and agent technology, which provides a foundation for the development of semantic Internet of things [5]. Subsequently, some people proposed to use a different middleware to provide adaptive processing systems for the Internet of things environment. By classifying and labeling the intelligent devices of the Internet of things, the operating components are connected with network services, users, and objects, so as to solve the problems of heterogeneous information and sharing and reuse of intelligent devices [6]. Aiming at the diversity and dynamics of Internet of things data types, some people put forward semantic technology based on machine recognition and expression, and apply it to the description of intelligent devices, data sharing, and knowledge reasoning, which provides a theoretical basis for further research on semantic annotation and semantic understanding based on Internet of things ontology.

In the field of artificial intelligence, the introduction of ontology concept is mainly used for knowledge representation and knowledge organization [7]. With the continuous application and development of the Internet of things, the meaning of the concept of ontology and its elements have also changed. In the application field of Internet of things, the relationship between entity objects is mainly described by ontology. Therefore, the description of object concepts and their relationships in different application fields can be transformed into the same or similar ontology, so as to provide semantic basis for the interaction between heterogeneous devices and things. Establishing the corresponding ontology model according to different Internet of things application systems is very important to realize the data perception, semantic association, and fusion of Internet of things [8]. Although different Internet of things application systems have differences in the construction of ontology model, there may be a certain degree of data and semantic relevance between different systems. Therefore, its universality and matching should be considered when constructing the Internet of things ontology model.

Because the ontology model of Internet of things is usually related to the application field, these ontologies not only are limited to describing the concepts in this field, but also need to redefine the existing ontology model when adding new concepts, so the scalability of ontology is poor. In addition, when an Internet of things application system needs to add new relationships between concepts, it needs to traverse the existing element relationships in all ontologies, which undoubtedly increases the additional time overhead [9]. Although the use of semantic technology can enable the application system to publish a large amount of domain-related information through the semantic web, due to the data transmitted to the Internet from different devices or systems, and the lack of semantic relevance between a large amount of data, the machine cannot achieve the expected effect when interpreting and responding to the data.

In recent years, some scholars have proposed a semantic interaction model based on ontology technology, which provides a basis for entity interaction between different systems or heterogeneous devices [10]. Because the model includes the association relationship between service entities in the ontology, it can meet the actual needs of users by semantic annotation and knowledge reasoning, so as to avoid the impact of multisource data or heterogeneous devices on semantic interaction. Semantic interaction includes not only the interaction between intelligent devices or entities in the Internet of things, but also the interaction process between users and intelligent entities [11]. Using ontology theory and semantic technology to study the interaction between users and intelligent entities not only needs to identify the actual needs of users from a large number of perceptual data, but also needs to establish a common interaction channel between different users and intelligent devices, so as to effectively provide users with the required services.

## 3. Semantic Technology Foundation of Internet of Things

*3.1. Semantic Internet of Things.* With the rapid development of Internet of things technology and its application, various devices related to Internet of things are gradually increasing, and the perception and control requirements for Internet of things devices are also gradually improving. Due to the heterogeneity of different devices, the access and use of Internet of things resources are not ideal. The semantic technology based on machine recognition solves the resource description, data sharing, and information integration of Internet of things [12]. Using semantic technology in the Internet of things and making full use of the characteristics of semantic knowledge representation and data sharing to build the semantic Internet of things can provide a technical basis for the interaction of Internet of things resources.

As a method or model to solve the internal contradiction of the Internet of things, semantic Internet of things mainly constructs an intelligent service system that can cooperate with each other on the basis of the existing Internet of things, Internet, and communication network from the perspective of the interactive relationship between the elements constituting the information ecosystem. Semantic Internet of things effectively integrates different software and hardware resources and systems, organizes various heterogeneous objects, and realizes the intelligent interaction between people and things through semantic collaboration.

Semantic Internet of things integrates the relevant functions of semantic web, wireless sensor network, and Internet. Semantic technology is applied to the Internet of things. Through semantic annotation of the information of Internet of things devices, people, things, and devices in the Internet of things can have a unified recognition language [13]. Through the devices in the Internet of things and the semantic method based on ontology, we can accurately find the information on the network and make further reasoning on the information according to the existing knowledge, so as to effectively realize the network intelligence. As shown in Figure 1, the relationship between semantic Internet of things, wireless sensor network, Internet, and Internet of things is described.

Although the traditional Internet of things has the characteristics of openness and flexibility, due to the diversity of information forms of Internet of things devices and the inconsistent understanding and description of information by different users and devices, the resulting information diversity makes the data analysis inaccurate and then affects the application effect of Internet of things.

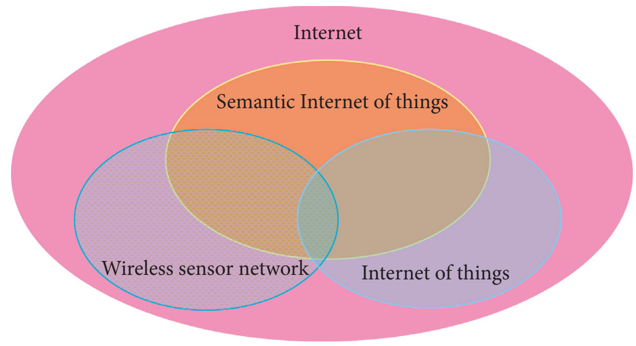


Figure 1: Relationship between semantic Internet of things and other different networks.

*3.2. Semantic Data and Features.* Semantic data are stored in ontology, which is not only the premise of the realization of semantic Internet of things, but also the condition of information sharing and exchange on the Internet [14]. Semantic Internet of things has the basic functions of semantic web and Internet of things at the same time. As shown in Figure 2, it is a schematic diagram of the working process of semantic Internet of things.

The article information provided by the producer needs to be standardized through coding, and then, the encoded information is saved in the electronic label. Then, the intelligent device and decoder are used to extract the target information. Because the information of objects is an ontology marked with semantics, it provides information for sharers and completes further reasoning through ontology and partial order relationship. At the same time, the information of the extracted object is released to the Internet through the machine reading device, and the information of the object can be shared.

From the working process of semantic Internet of things, ontology not only is a form of semantic annotation of the information of things, but also can provide specific information of things for sharers through partial order relationship. Therefore, ontology is very important in semantic Internet of things [15]. As shown in Figure 3, it reflects the role of ontology in different application scenarios.

As a knowledge base, ontology uses semantic annotation to reflect the things and their relationship in different fields. By combining the specific field characteristics, it can establish the corresponding knowledge system for the field. In recent years, ontology technology has been well applied to the Internet of things, e-commerce, and other related fields. Using ontology technology can effectively solve the heterogeneity problem in different Internet of things applications. As shown in Figure 3, due to the different regions and application fields of smart city and smart medical, the data provided by the two Internet of things platforms cannot be directly used for the development of remote service applications.

Ontology mainly includes objects, instances, relationships, attributes, and other related elements. Among them, the object is mainly used to describe something, and the object can contain one or more sub-objects to describe a specific thing. Examples are mainly used to describe the specific things contained in a certain class of objects. Relationship is used to represent the ownership relationship between things and attributes [16]. Property is used to describe the properties of objects and sub-objects.

In order to facilitate the description of things and their internal relations in ontology, directed graph can be used to describe the relationship between various elements of ontology. As shown in Figure 4, an example of an ontology is reflected through a directed graph.

*3.3. Intelligent Application and Semantic Collaboration of Internet of Things.* The intelligent application platform established by the Internet of things is usually a system of human-computer interaction and cooperation. The system

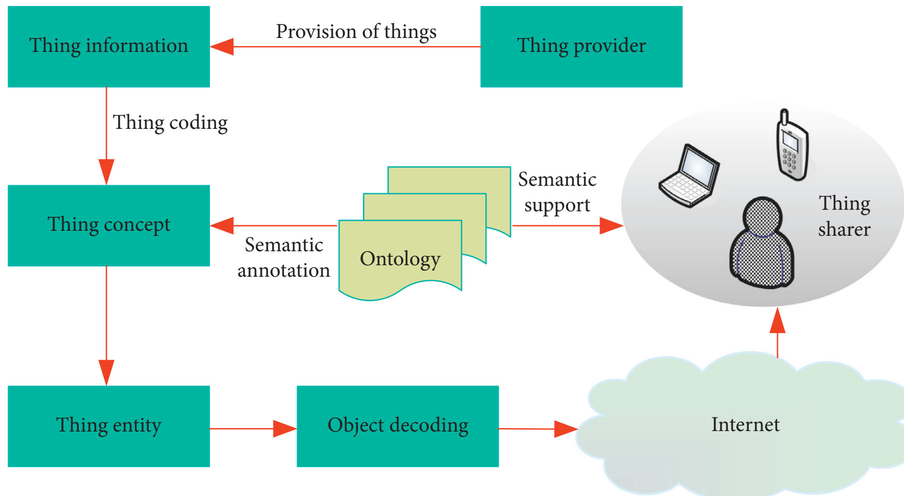


Figure 2: Schematic diagram of the working process of semantic Internet of things.

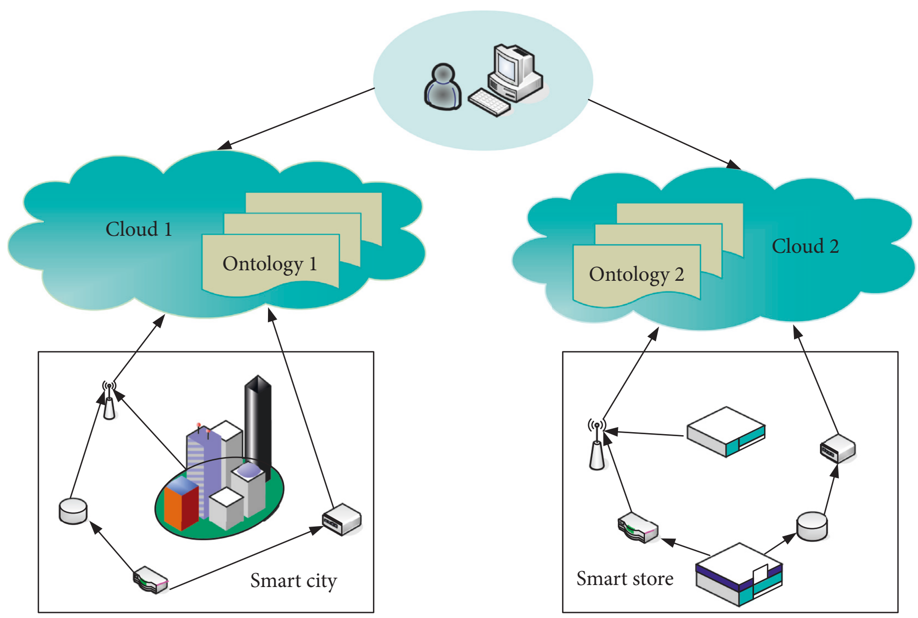


Figure 3: The role of ontology in different application scenarios.

organizes a large number of sensors, embedded computers, and information devices into a network structure through universal network in order to meet different application requirements [17]. As shown in Figure 5, it is a schematic diagram of intelligent application mesh space established based on the Internet of things.

Users can use various intelligent terminal devices to interact with the intelligent application platform, so as to meet the specific needs of users. By automatically monitoring the dynamic information about intelligent devices, the intelligent application platform can not only provide various control and management functions for different users, but also put forward effective countermeasures for events in the intelligent system [18]. Because the intelligent application system has good dynamics, the user's terminal equipment can interoperate with the intelligent system at any time. Due to the deployment of a large number of

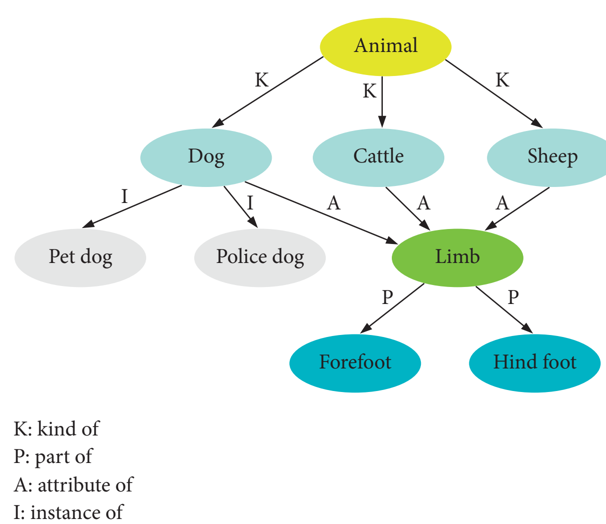


Figure 4: Directed graph representation example of ontology.

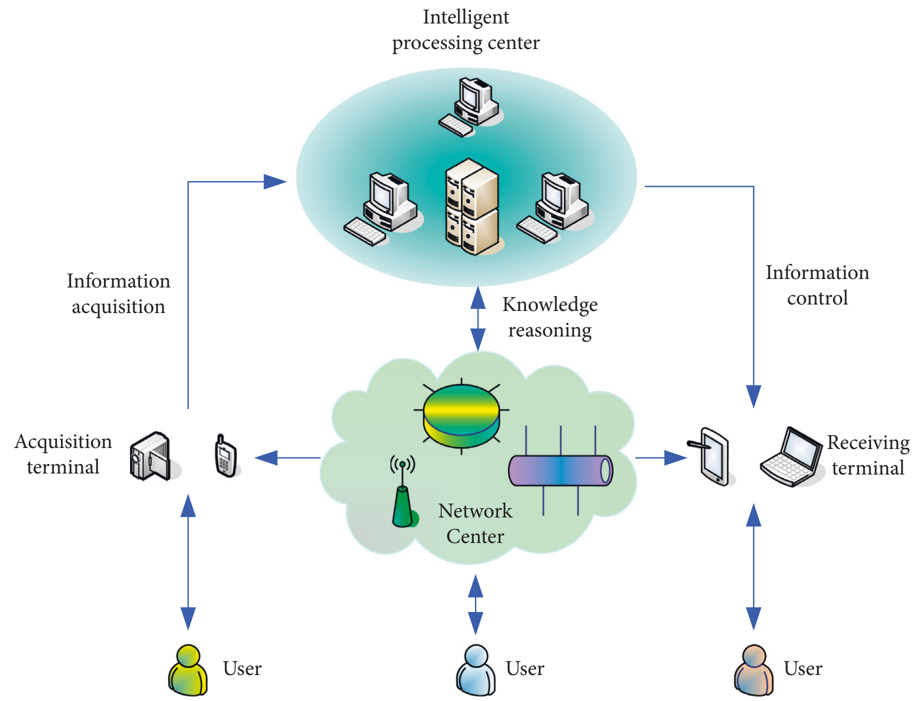


Figure 5: Architecture diagram of intelligent Internet of things application platform.

wireless sensors in the intelligent application system, it can process the information perceived by users in real time and feed back the processing results to users in time.

Because the intelligent application platform integrates a variety of devices and network systems, it not only has a large amount of data computing tasks and heavy work of digital fusion processing, but also affects the cooperation between heterogeneous devices. Because different devices may adopt different operation standards, it is necessary to realize the collaborative work of different devices with the help of an interoperability framework, semantic web. Providing different devices with semantic information that is helpful for Internet understanding through semantic web can not only realize the automatic operation of tasks, but also avoid the shortcomings caused by manual operation.

In order to give full play to various service functions provided by intelligent application platform, semantic collaboration is usually adopted to solve the problem of heterogeneity between devices. Semantic collaboration mainly regulates the information interaction process between different entities in the Internet of things environment, so as to ensure the smooth realization of the Internet of things. Semantic collaboration realizes the information sharing between different things in the Internet of things by solving the problem of semantic heterogeneity. Semantic collaboration mainly uses semantic correlation analysis and semantic mapping to deal with semantic heterogeneity in the Internet of things [19]. On the basis of judging the correlation between heterogeneous semantics, semantic mapping is used to transform unrelated semantics, and a mapping relationship is established.

Because the heterogeneity of ontologies in different fields affects the service function of intelligent application platform, it is necessary to standardize the processing of different ontologies through semantic collaboration. As a common method of semantic collaboration, ontology matching can effectively solve ontology heterogeneity, information sharing, and interoperability. Ontology matching mainly uses the semantic relationship between two different ontologies to find their matching elements, so as to obtain knowledge that can be shared by different entities.

Ontology matching can not only establish the corresponding relationship or semantic mapping between different ontology concepts, but also calculate the similarity between different ontologies. At present, common ontology matching methods include ontology methods based on morphology or semantics, and matching methods based on rules or statistics. Different matching methods have their own characteristics in practical application. We need to combine specific objects and adopt a variety of methods to realize ontology matching.

## 4. Semantic Model of Internet of Things Based on Intelligent Translation and Learning

*4.1. Intelligent Translation Architecture.* The common ontologies in intelligent application platform are various service ontologies and user ontologies. Due to the heterogeneity and mismatch of different ontologies, it is difficult for users to obtain the services provided by the intelligent system. In order to solve the problem of interoperability between heterogeneous devices in the Internet of things environment, it is necessary to match the user data with the data stored in the intelligent Internet of things system.

For different ontologies in the intelligent Internet of things system, in order to realize the interoperability between ontologies, it is necessary to match the user ontology and system ontology, so as to realize the interoperability between users and systems through intelligent translation. According to different matching objects, ontology matching can be divided into ontology element matching and ontology structure matching.

For two different ontologies, we need to compare the similarity of all elements in the two ontologies according to the synonyms of the two ontologies. If the similarity value range of two ontologies is 0–1, when the similarity of two elements is 1, it means that the two elements are exactly the same [20]. When comparing all elements of two ontologies, the comparison result can be expressed as matrix $H$ based on similarity, which is shown as follows:

$$H = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{m1} & a_{m2} & & a_{mn} \end{pmatrix}, \tag{1}$$

where $H$ denotes a matrix with $m$ rows and $n$ columns. $m$ is the number of elements contained in ontology 1, and $n$ is the number of elements contained in ontology 2. The element value of matrix $H$ represents the similarity based on fuzzy string comparison.

Semantic distance query method can realize semantic similarity matching. As shown in Figure 6, it shows the flowchart of matching two ontologies.

Ontology matching for strings is mainly to match all elements contained in different ontologies. It is mainly to compare the similarity of strings contained in ontologies, which has nothing to do with the semantic information of ontologies. This method mainly determines the similarity between two ontologies from the perspective of the similarity of two strings. If the similarity of two strings reaches a certain value, it can be considered that the two strings are similar.

In string-based ontology matching, the similarity of two ontologies can be calculated by editing times similarity method. The number of edits is the minimum number of edits required to convert one string to another [21]. For example, when editing a string, you can convert one string to another by replacing, inserting, or deleting it. The calculation formula of editing times similarity is as follows:

$$SIM_t(e_1, e_2) = 1 - \frac{\text{times}(e_1, e_2)}{\max(|e_1|, |e_2|)}, \tag{2}$$

where $\mathrm{SIM}_t$ represents the editing times similarity between the two ontologies, and $e_1$ and $e_2$ are strings in two ontologies, respectively. $\text{times}(e_1, e_2)$ is the number of edits of two strings. $\max(|e_1|, |e_2|)$ is the maximum length of two strings.

String-based ontology matching is to match the ontology from the perspective of the font of ontology elements, without considering the semantic content between different ontologies. In order to match the similarity of different ontologies from the semantic perspective of ontology elements, a matching method based on linguistics needs to be adopted. Therefore, the semantic similarity of different ontologies can be calculated with the help of WordNet. WordNet can use the semantic relationship of ontology to construct vocabulary. The semantic relationship of ontology mainly includes synonym relationship, upper and lower relationship, antonym relationship, part and whole relationship, etc.

WordNet organizes the semantic units of ontology in a tree way. Nodes refer to the collection of ontology units with the same semantics, and edges refer to the correlation between different nodes. As shown in Figure 7, the tree structure composed of different semantic units in the ontology described by WordNet is adopted.

The semantic similarity between two ontologies can be expressed by their distance in the tree. The calculation formula of semantic similarity of different ontologies is as follows:

$$\mathrm{SIM}_s(e_1, e_2) = \frac{1}{2}\left(\frac{\mathrm{Len}(s_1, s_2)}{\mathrm{Len}(s_1, s_r)} + \frac{\mathrm{Len}(s_1, s_f)}{\mathrm{Len}(s_2, s_r)}\right), \tag{3}$$

where $s_1$ and $\mathrm{Len}(s_1, s_2)$ represent the meanings of lexical units $e_1$ and $e_2$ in their respective ontologies, $s_f$ is their parent node, and $s_f$ is the root node of the tree. $\mathrm{Len}(s_1, s_2)$ denotes their distance in the tree.

The distance calculation formula between semantic units of two ontologies is as follows:

$$\mathrm{Len}(s_i, s_j) = \frac{1}{\sum_P \sum_{k=P_i}^{P_j} w_k}, \tag{4}$$

where $s_i$ and $s_j$ are ontology semantic units, $w$ is the weight of semantic relationship between $s_i$ and $s_j$, and $P$ represents the path set from $s_i$ to $s_j$, which contains all paths connecting $s_i$ and $s_j$ nodes. According to the above calculation formula, the semantic similarity between different ontologies is inversely proportional to the distance between them.

*4.2. Semantic Learning Method Based on Cyclic Neural Network.* Since the string after ontology matching is mainly a serialized information string, in order to obtain the complete information of ontology, these serialized data need to be further used for modeling to generate the required specific text information. The general neural network method is usually used to process a single input information. Because it is unable to distinguish the internal relationship between continuous input information, it is not suitable for processing sequential data. Therefore, the method of recurrent neural network (RNN) can be used to learn and train the serialized data and generate the corresponding text [14]. Because the memory and parameter sharing of RNN are very beneficial to the nonlinear feature learning and processing of sequence data, RNN is widely used in natural language processing fields such as machine translation and language modeling.

The hidden state of RNN model is mainly used to store information. Therefore, the model has a certain memory

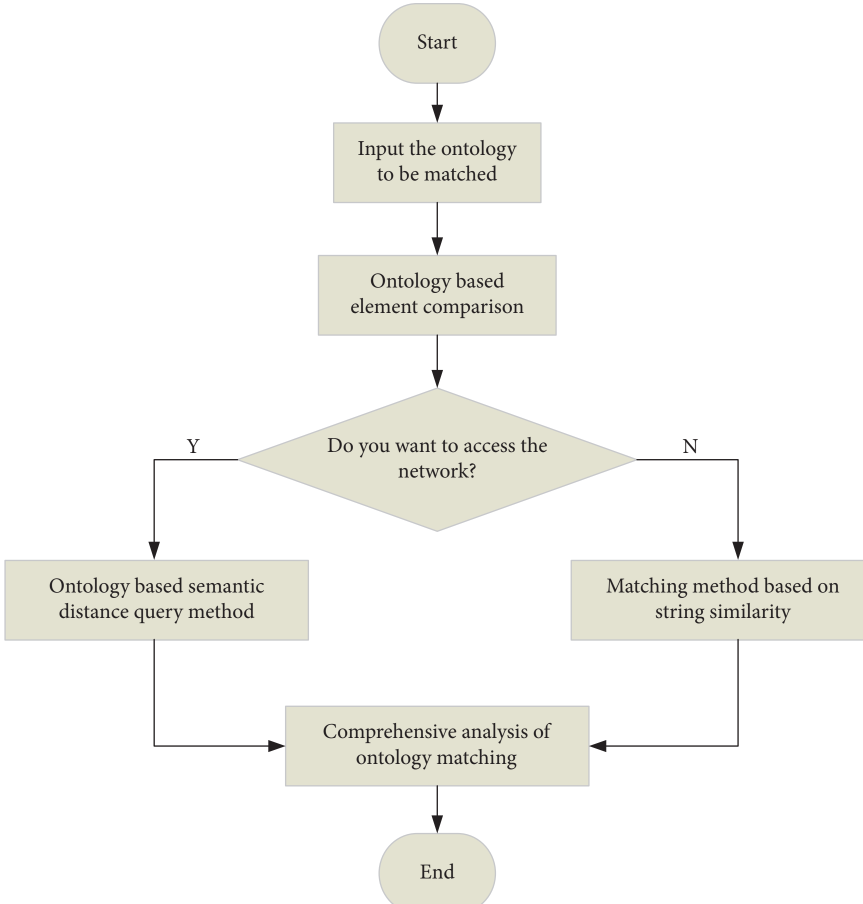


Figure 6: Schematic diagram of ontology matching process.

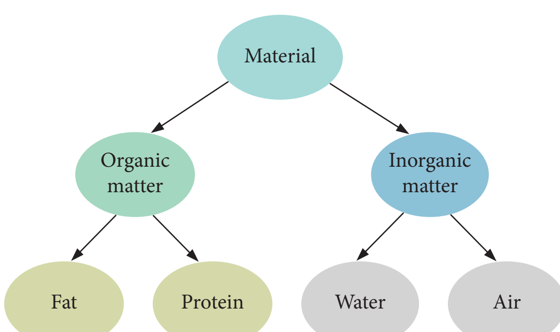


Figure 7: Tree structure of ontology elements based on WordNet.

function. The input object of RNN is usually a set of vector sequences, and the network model can use the last output value to generate the current output result. The model uses one input object at a time to generate an output result, which depends on the last data sequence.

As shown in Figure 8, the composition of the cyclic neural network model is shown. On the left is the unexpanded part of the RNN, and on the right is the successively expanded part of the RNN after processing the sequence input values.

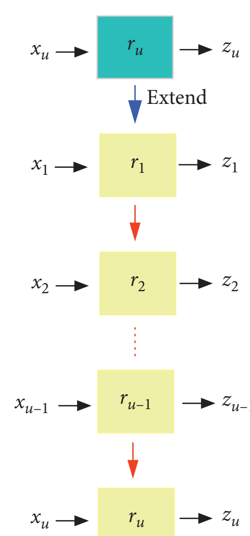


Figure 8: Composition diagram of cyclic neural network model.

In Figure 8, $x_u$ represents the input part of the model, $r_u$ is the hidden layer, and $z_u$ is the output result of the model. The above relationship can be expressed as follows:

$$r_u = g(r_{u-1}, x_u),$$
$$r_u = g(W_{xr}x_u + W_{rr}r_{u-1} + c), \tag{5}$$

where $W$ is the weight matrix and $c$ is the offset coefficient. The output result can be expressed by the following formula:

$$z_u = f(W_0 r_u + c_0). \tag{6}$$

According to Figure 8 and the above calculation formula, the value of $r_u$ is determined by $r_{u-1}$ and $x_u$. $r_{u-1}$ indicates that RNN has certain memory function, and its value is determined by $r_{u-2}$ and $x_{u-1}$. Therefore, the value of $r_u$ is determined by $x_1, x_2, \cdots, x_{u-1}$; that is, RNN memorizes the previously input sequence information. Since the result of RNN is output successively from left to right, and the weight matrix $W_{rr}$ corresponding to each sequence information is unchanged, it can not only reduce the complexity of model parameters, but also remember the previous sequence information.

*4.3. Semantic Model of Internet of Things.* In order to realize the perception and representation of the context information of the Internet of things, this paper constructs a semantic model of the Internet of things based on intelligent translation and learning. As shown in Figure 9, it shows the construction process of the semantic model of the Internet of things.

Firstly, we need to collect data, extract the processing functions required by things or services, such as turning on the air conditioner, and closing doors and windows, and map them to the corresponding item layer. The processing functions of these different services can be combined and interacted with each other.

Then, several function sequences are created according to user needs and specific Internet of things application scenarios. Related semantic tags are included in functions, such as semantic text descriptions of functions. The specific interaction between different functions is determined by user requirements and service providers. In the context-aware layer of the Internet of things, a set of function sequences are composed of different functions.

For the semantic tags contained in the function sequence, the semantic measurement method can be used to establish the corresponding semantic relationship diagram. Because users need different services, the meanings of edges and weights in different semantic graphs are also different. Therefore, ontology semantic matching method needs to be used to integrate different types of semantic maps, so as to obtain the context map of the Internet of things. Through the learning and representation of the context map of the Internet of things, the interactive operation of users, things, and information can be realized, for example, various service recommendations and intelligent interactive process in Internet of things applications.

In order to objectively and accurately evaluate the text generated by the semantic model of the Internet of things, Bleu (bilingual evaluation understudy) can be used to effectively evaluate the fluency, accuracy, and coherence of the text content of the output result of the model.

Bleu is mainly used to evaluate the results of machine translation. High-quality machine translation usually overlaps with the reference translation. When there are more similar parts with the reference translation, the greater the value obtained by Bleu. Therefore, the similarity between the generated text and the reference text of the semantic model of the Internet of things can be obtained according to the similar parts of the semantic model of the Internet of things. The calculation formula is as follows:

$$\text{Bleu} = \eta \times \exp\left(\sum_{i=1}^{M} w_i \log p_i\right),$$
$$\eta = \begin{cases} e^{(1-l_r/l_s)} l_s \le l_r \\ 1\, l_s > l_r \end{cases}, \tag{7}$$

where $p_i$ represents the accuracy rate of the translated text, $w_i$ is the weight of the corresponding text, $M$ denotes the number of words, $\eta$ is the penalty factor, $l_s$ is the length of the translation generated by the model, and $l_r$ is the length of the reference translation.

## 5. Experiment and Analysis

*5.1. Experimental Design and Evaluation Index.* In order to verify the semantic model of Internet of things based on intelligent translation and learning, this paper designs an application scenario of Internet of things. When the user enters a commodity intelligent purchase platform of the Internet of things application system, and the user uses the mobile terminal with knowledge intelligent processing module to send the commodity purchase service request to the purchase platform, the Internet of things application system will respond to the service request put forward by the user in time. Then, the real-time ontology matching and processing are carried out through the commodity intelligent purchase platform, and the commodity purchase results are fed back to users through the Internet of things equipment, so as to complete the whole interactive operation. The ontology of commodity purchase description in the ontology of Internet of things application system is adopted. Select 100 knowledge intelligent processing devices to represent the application devices in the commodity intelligent purchase platform. After sending the purchase service request to the knowledge intelligent processing equipment, the matching results of the purchase service are analyzed.

Experiments were carried out on the query and matching of 20 groups of commodity purchase services by grouping. The number of intelligent device services selected by each group was 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 in turn. In order to facilitate the comparison with the model proposed in this paper, the ontology matching method based on semantic similarity and the ontology matching method based on WordNet semantic distance are used for comparative experiments. The experimental results obtained by different methods are counted, the precision and recall of each group of experiments are calculated, and then the different methods are evaluated and analyzed.

When evaluating the performance of the semantic model of the Internet of things based on intelligent translation and learning proposed in this paper, we first need to evaluate the

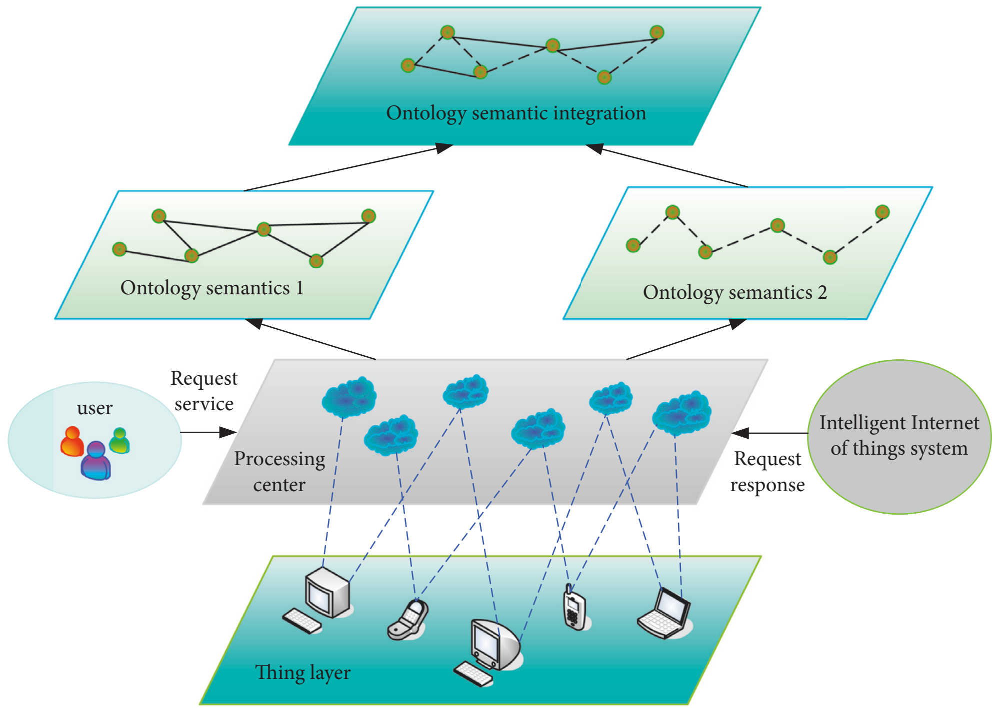


Figure 9: Workflow diagram of semantic model of Internet of things.

accuracy of the results of goods purchase services requested by users through the Internet of things application system, that is, the accuracy (ACC) [22]. The calculation formula is as follows:

$$\mathrm{ACC} = \frac{C_q}{C_r} \times 100\%, \tag{8}$$

where $C_r$ represents the result returned by the intelligent system of the Internet of things after service response to the user's demand and $C_q$ denotes the requested service required by the user.

In addition, it is necessary to evaluate the integrity of the services provided by the Internet of things application system after the user makes a request, that is, the recall rate (REC). The calculation formula is as follows:

$$\mathrm{REC} = \frac{C_1 \cup C_2 \cup \cdots \cup C_{k-1} \cup C_k}{C_q} \times 100\%, \tag{9}$$

where $C = \{C_1, C_2, \cdots, C_{k-1}, C_k\}$ represents the set of required results obtained by the intelligent system of the Internet of things after responding to the user's needs and $C_q$ is the set of requests required by the user.

Through the accuracy and recall, we can evaluate the service results provided by the Internet of things application system and satisfy users. They can intuitively reflect the function and efficiency of the intelligent Internet of things service system.

## 6. Results and Analysis

Under the same conditions, different methods are adopted and the service request is sent to the intelligent system of the Internet of things according to the user service request ontology, and then the service results are compared. In this paper, the following experimental statistical results are obtained by averaging 10 experiments. As shown in Figure 10, it shows the number of system return results obtained by different methods.

It can be seen from Figure 10 that the model proposed in this paper obtains fewer results than other methods when realizing ontology matching, which reduces the redundancy of the results. At the same time, more results are obtained than the traditional ontology matching method, which ensures the completeness of query results to a certain extent, so as to ensure that all results that meet the needs of users are obtained.

As shown in Figure 11, the comparison results of service precision obtained by different methods are shown.

According to the comparison results reflected in Figure 11, the service precision obtained by the ontology matching method based on semantic similarity is low, while the service precision obtained by the ontology matching method based on WordNet semantic distance is relatively high. The service precision obtained by this method is higher than that of other methods.

As shown in Figure 12, the comparison results of service recall obtained by different methods are shown.

According to the comparison results reflected in Figure 12, the recall rate obtained by using the ontology matching method based on semantic similarity is relatively low, while the recall rate obtained by using the ontology matching method based on WordNet semantic distance is similar to the method proposed in this paper and is significantly higher than that by using the ontology matching method based on semantic similarity. This shows that the

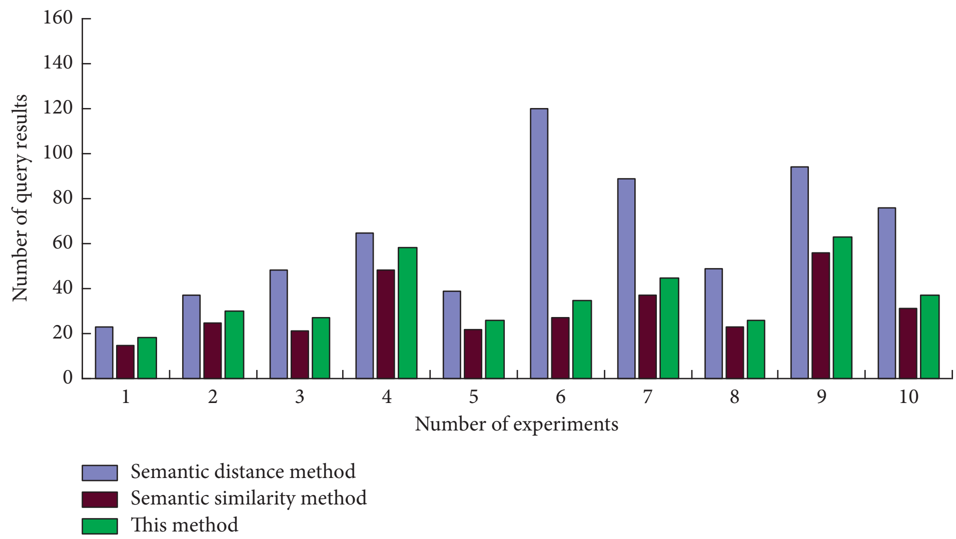


Figure 10: Number of query results obtained by different methods.

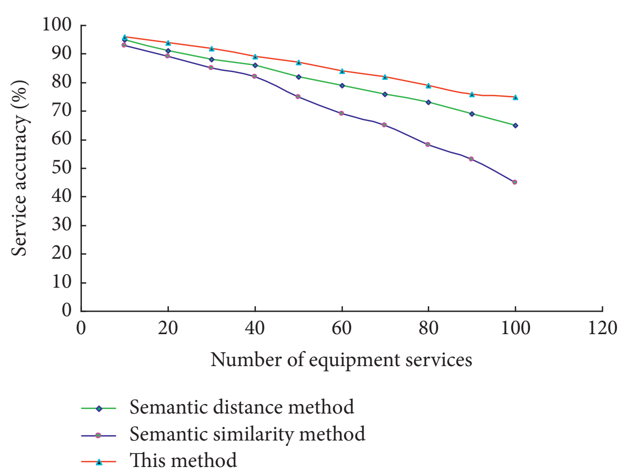


Figure 11: Comparison results of service accuracy obtained by different methods.

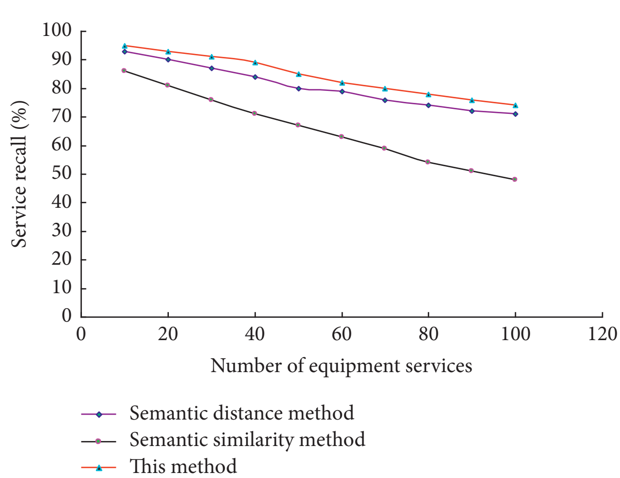


Figure 12: Comparison results of service recall rate obtained by different methods.

semantic model of Internet of things proposed in this paper can better meet the recall requirements of Internet of things intelligent system for user services.

## 7. Conclusion

Aiming at the problem that the existing methods were difficult to solve the semantic interoperability and data interaction between heterogeneous systems of the Internet of things, this paper proposed a semantic model of the Internet of things based on intelligent translation and learning. Based on the analysis of the theory of semantic Internet of things, this paper summarized the semantic data and its characteristics, as well as the common methods of semantic collaboration and ontology matching of Internet of things. According to the characteristics of service ontology and user ontology contained in the intelligent system of Internet of things, an ontology matching method based on string and semantic relationship was proposed. The organic integration of ontology semantic data information was realized through the cyclic neural network method, and a semantic model of Internet of things based on intelligent translation and learning was constructed to realize the perception and representation of the context information of Internet of things. The experimental results showed that the semantic model of the Internet of things proposed in this paper was better than the traditional ontology semantic matching method in accuracy and recall, and had achieved good system application results. This research can provide theoretical support and technical reference for the in-depth study of intelligent device interaction and multisource data sharing in the Internet of things.

## Data Availability

The labeled dataset used to support the findings of this study is available from the corresponding author upon request.

## Conflicts of Interest

The author declares that there are no conflicts of interest.

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