Basic Dimensions and Concepts of the Internet of Things from the Perspective of Philosophy & Category Theory

Juzheng Zhang
Institute of Modern Logic and Application, Nanjing University, Nanjing, Jiangsu, 210093, China
Research base of Agriculture culture and rural development in Central Plains, Xuchang, Henan, 461000, China
linkstone@smail.nju.edu.cn
1985325@Zjz

Abstract: The Internet of Things (IoT) is a new form of information application based on the Internet. It endows information to the "things" of substantial being through the form of electronic tags, aiming at realize the global sharing of the information of things. The IoT technology starts with the identification of "things", in the classical understanding of category theory that "things" belong to different categories; there are clear boundaries between categories; all the "things" in the category are the "things" as substantial being. With the appearance of prototype category theory, many questions have been raised about classical understanding,especially in the question of whether categories have definite boundaries. The current IoT technology is still based on the category theory that "things" as substantial being,which will inevitably bring a series of challenges to the development of the IoT at the operational level.
Keywords: Category Theory; Things; Categorization; Prototype

1. INTRODUCTION

1.1 The Basic Dimensions Of Iot: The Identification Of "Things"

The concept of the Internet of things originated from Professor Kevin Ashton (1999) of the MIT, who proposed the Radio Frequency Identification (RFID) system As defined by the International Telecommunication Union(ITU,2005), The Internet of things(IoT) is a network that connects all things with the Internet through information sensing equipment such as RFID,thus realize intelligent identification and management (UIT, 2005). The conception of IoT is based on RFID , electronic code (EPC) and other technologies, on the basis of the Internet through agreed protocols, through sensing devices in accordance with the agreed protocol, to construct a real-time sharing Internet of things information.The foundation of the IoT is still the Internet, it’s useful side extends to the information exchange and communication between things, that forming a network connected with the information of "things".The European Commission's(2009) definition of IoT expresses this understanding directly, They consider that the IoT is an extension of computer network, extending it to the interconnection between things. These things have IP addresses,embed into complex systems,obtain information from the surrounding environment through the sensors,and obtain the information for response and processing (Communities, 2009)

With the popularization of IoT technology and the deepening of related research, its concept and supporting technology is constantly developing. The connotation of IoT not only includes the integration of things into the web to realize the recognition and control, but also includes the transmission and intelligent processing of information (Absil et al., 2021).The technologies covered by the IoT have also been upgraded from the original sensor-related technologies to:

(1) The perception-layer technologies including data collection, sensor network networking and collaborative information processing. (2)Network-layer technology of Internet heterogeneous network fusion, M2M (Machine-to-Machine) wireless access, etc. (3)The application-layer technology of IoT that contains an application of sub-layer support(Spiess et al., 2009)

In conclusion,The IoT technology does not reconstruct a physical structure, it’s just is a is a way of sharing information which based on Internet.

The difference between the Internet and IoT is that the information transmitted on the network is the information of "things".The IoT deals with "things" by giving information to related objects.The original natural language symbols on paper are replaced by electronic tags, so as to support the remote reading, global transmission and intelligent processing of basic product information (Akıncıoğlu et al., 2021).

2. COGNITION AND PROCESSING OF "THINGS"IN IOT

The purpose of IoT is to connect things in the world, so what is "thing"?From the perspective of philosophy,thing has two levels of meaning: Matter and thing.The two concepts of matter and thing are the same series, but not the same level of concept.

Matter is a philosophical ontological concept, which generally refers to all the existence in the universe except spirit. Matter corresponds to Spirit.The IoT usually refers to all kinds of things made by human, namely artifacts or products.It is the thing that has the physical existence as the substantial being.

2.1 The Cognition Of Thing In Classical Category Theory: The "Things"As Substantial Being

Parmenides of Elea in ancient Greece first put forward the concept of ‘on(being)’, which opened the unique philosophical tradition of ‘being as being(ontology)’in the western civilization.In Aristotle's view, numerous beings are not equal and parallel, but it’s is centered on the primordial, fundamental being, and other beings (or categories) are attached to the substance.

In the Categories, Aristotle established two criteria for categorization of categories by analyzing the relationship between meaning and reference, subject and predicate and their objects.First, the logical criteria.That is the criterion of whether one thing is said of a subject.As known that the logic established by Aristotle is subject-predicate logic.Whether a term can be used as a predicate to express the subject or not which shows the meaning of the term and the object to which the thing it expresses belongs.Not only the term describe the subject, but the definition of the term also describes the subject.Secondly, the ontological criteria. That is the criterion of whether one thing in a subject or not.In a subject means what is in something, not as a part, and cannot exist separately from what it is said.The essence of this criterion is whether it’s in the subject."In a subject" refers to the category of substance, while "not in a subject" refers to various categories outside the substance.As far as sequences of existence are concerned, the ontological meaning of categories comes first and the logical meaning comes with it.The latter is derived from the former.After all,the logical meaning of category is based on the meaning of being itself.

In Categories Aristotle concretely divides "being" into ten: substance,quantity,qualification,relative,where,when,being-in-a-position,having,doing,being-affected. (Aristotle, 1984) Among all the categories listed, substance undoubtedly at the heart of all categories.The other nine categories can be used to describe substance, but substance does not describe the other nine.The other nine categories exist in substance and are derived from substance.When the other nine categories changes, the substance remains the same.In Metaphysics, Aristotle argues that "Now there are several senses in which a thing is said to be primary;but substance is primary in every sense—in formula,in order of knowledge,in time.For of the other categories none can exist independently,but only substance.(Aristotle, 1984) Aristotle actually replaced "The science of being as being" with "The science of substance as substance".In fact, being in Aristotle’s ontology is subordinate to substance.Substance is above all other categories and is the heart of them.

In the category of substance, primary substance "is that which is neither said of a subject nor in a subject"(Aristotle, 1984) For example, individual things (the individual man or the individual horse) are the primary substances, "genus" and "species" that containing individual things are secondary substances.The secondary substances depend on the primary substances.Without individual people, there would be no genus of man and no species of animal.Meanwhile, only the genera and species which secondary substances itself can be more precisely accounts for what is primary substances.Thus Aristotle pioneered the scientific definition of genus+species.A genus is the kind of thing to which the defined object belongs,and species is the essential characteristic that distinguishes the defined object from other things.

The Classical Category Theory can be briefly stated as follows: (1) Categories are defined in terms of a conjunction of necessary and sufficient features. (2) Features are binary. That is, each property either works or doesn't work in defining a category,one thing either has the property or not.There is no such thing as "It has some kind of property, and meanwhile it's not". (3) Categories have clear boundaries.Once established, a category divides things into two, that is, one thing belongs to a category or not.There is no such thing as "It's belonging to one category and meanwhile it's not". (4) All members of a category have equal status.(Taylor, 2003) The Classical Category Theory is based on idealized objects. It's advantage is that it can quickly grasp the essence of the object and conveniently explain some deterministic individual categorical phenomena.

2.2 The Treatment Of "Things" In Iot

As mentioned above， the IoT deals with "thing" by giving information to related objects.thing as a substantial being either within a certain category or not.Meanwhile,one of the main goals of the IoT is to realize intelligent processing and global sharing of information about things.In the Internet era, the exchange of information is actually between H2H(people to people). On this basis, the IoT extends to H2T (people to thing) and T2T (thing to thing).In a sense, the "things" in IoT are no longer the "things" of physical existence, but the information of "things".At this moment, the critical point of processing the information of "things"lies in the fact that,how to realize that every reading agent (human or machine)can understands the information of "things" it receives.It depends on two layers:"Readability"&"readable"."Readability" means the information of "things" being accessed is easy to understand which means establish a standardization of descriptions of the information."readable" means the "readers(reading agent) "should have the background knowledge database.

In terms of the Internet of things,The"readable" level is the shared knowledge database which helps every reading agent to understand the information of things.The "readability" level is the standardization of the information description of things.There are two aspects as the standardization of the information description of things.

A. Standardization of formats.This is relatively feasible through the establishment of a world recognized IoT standardization organization, which specifies the thing's information that the electronic tag must have.The specific measure includes the naming standards,necessary content and representation form of the corresponding information in the server of Internet of things.The current achievements related to this are mainly reflected in the standardization of RFID coding:electronic product code(EPC)led by US & universal identification(UID)led by Japan. (Nath et al., 2006)

B. Standardization of terms.This can be difficult or even impossible.For one thing, the languages and cultures of different countries are very different. On the other hand, the Polysemy & Multi-word phenomenon of one meaning was very common.

The ontology of the Internet of things is constituted by the "the shared knowledge database which the reader should have" and the "centralized validation semantics"of the thing's information description standardization.The greatest contribution of ontology to the standardization of IoT terms is to enable the reading agent(human or machine) which reading the electronic tag to be able to understand the semantic of the information shown in the tag.

Ontologies have long been seen as a synonym for the metaphysic founded by Aristotle.With the development of science, metaphysics has gradually embraced more areas of research.Ontologies are actually a branch of metaphysics and meanwhile it's also the basis of metaphysics.At the present time, ontologies continue to undertake the research of the "being" in the philosophy world, and have become the foundation of philosophy.Ontology is an objective description of the real being in a certain field of the world.The truth of a proposition formed on the basis of the description can be determined by the existence or nonexistence of relevant facts.

Since the 20th century, ontologies have been widely used in science to develop a common concept which shared within a field of research, so that knowledge can be shared and reused.Quine(1948) studied ontology from the linguistic level through the method of logical analysis, and put forward the "ontological commitment".(Quine, 1948)He argues that one's use of language is an ontology to which one makes a commitment.That is to say that Quine deals with ontological issues in the framework of language.What exists does not depend on language,but someone say something exists(or say ontological commitment) can't get away from language.In the following research, Quine restates the meaning of "being" through the language of predicate logic,"But,this is,essentially,the only way we can involve ourselves in ontological commitments: by our use of bound variables."(Quine, 1980) That is to say, "ontological commitment" actually refers to the ontology contained in the range of variables, and the commitment is determined by the predicate contained in the variable.The range of things which a theory assumes to exist depends on the manner in which the theory is formulated. Any logistic system implies its own ontology, which contains all the things that the theory assumes to exist.Therefore, logical theory is the ontological commitment of the existence of all things in ontology.

Inspired by Quine, McCarthy(1980) believed that there was overlap between philosophical ontology and the logical theory of artificial intelligence(AI).He proposed that an intelligent system based on logical concepts must list everything that exists and construct an ontology to describe our world. (McCarthy, 1980)

Genesereth & Nilsson(1987) regarded conceptualization as the basis for the formal expression of knowledge. Conceptualization "includes the objects presumed or hypothesized to exist in the world and their interrelationships." (Genesereth & Nilsson, 2012) Elements of a conceptualization contain objects, functions, and relations.

Conceptualization[0]: structure C=(Spiess et al., 2009), where D is a domain and R is a collection of relationships on on D.

The subsequent formalized ontology research uses the definition of conceptualization created by Genesereth & Nilsson as the basis. Tom Gruber (1993) for the first time borrowed the conception of ontology in the field of information science, and gives the widely accepted definition "An ontology is an explicit specification of a conceptualization.” Ontology model or say conceptual domain model is a theoretical description of objects, attributes and relationships among objects in a knowledge domain, an ontology can be defined by defining a set of specialized terms for the expression, and the usage of these terms can be restricted and regulated by formal axioms.

Nicola Guarino(1998) tries to make a clear distinction between ontology and conceptualization.He revised the definition of Gruber, arguing that Conceptualization[0] is limited and involves only the extension relation in the domain D.In other words, Guarino believes that the relation R describes only a particular state of the world, but not all of it, the concept of possible worlds in modal logic needs to be introduced--the domain space(Spiess et al., 2009)，It introduces the collection of all possible worlds in the domain.An n-ary conceptual relation on the domain (Spiess et al., 2009) is a mapping of the set of all possible worlds W to the set of all n-ary relations in the domain D.That is n-ary conceptual relationship P^n: 2^{D^n} .Guarino further defines the conceptualization C as:

Conceptualization: Ordered triplet C=(Spiess et al., 2009), where D is a domain; W is the set of related states of affairs in the domain, and it can also be called a collection of all possible worlds;R is the set of conceptual relations P^n on the domain space (Spiess et al., 2009).

Let L be a logical language and V is a set of its words, then L's ontological commitment K=(Communities, 2009), where conceptualization C=(Spiess et al., 2009). The function E： V→DUR is an explanatory function of ontological commitment K,where the elements of the domain D are assigned to constant symbols of L's vocabulary set V, and the elements of the set R are assigned to predicate symbols of vocabulary set V. (Guarino, 1998) Thus, Guarino expresses ontological commitment as a certain mapping between language and something called ontology.That is, an ontology should be defined as a formal mapping between terms in the knowledge database and terms that are the same or equivalent in the ontology.In other words, an ontology is a collection of logical theories designed to illustrate the intrinsic meaning of a formal language vocabulary.

To sum up, conceptualization is a semantic network composed of terms, term's definitions, and intersections among terms in a domain,it should contain the basic information that the ontology of the domain must have.At the same time, the ontology should also include a description of synonyms.Ontology is a clear representation and description of conceptualization, which includes four levels: (1) Conceptualization is a model abstracted from phenomena in the objective world; (2) Explicitation refers to the explicit definition of the concepts used and their constraints; (3)Formalization means that ontology concepts can be processed by intelligent machines. (4)Sharing means that ontology knowledge becomes a set of concepts recognized by the community in related fields.

The application of ontology on the web gives birth to semantic Web, which solves the semantic problem of information sharing on Internet.The conception of Semantic Web was proposed by Tim Berners-Lee (1998), inventor of the Internet. (Berners-Lee, 1998) The Semantic Web provides a common framework that allows data to be shared and reused across different agents.The Semantic Web makes it possible for machines to process data, either directly or indirectly. (Berners-Lee et al., 2006) In order to express the structure of ontology in the Web, metadata is used to describe concepts and the relationships between concepts.The World Wide Web Consortium(W3C)provides a series of recommendations for defining metadata:

("W3C Recommendation," 2014) XML (Extensible Markup Language) is a structured, machine-readable document specification.XML uses tags to describe the logical structure and the data layout of documents without any specific semantic restrictions, allowing users to customize tags.XML Schema is used to restrict the structure of XML documents.

RDF（Resource Description Framework）is a standard model for data exchange in the Web, which provides simple data semantics of object model.RDF describes various resources on the Web by defining triples such as resource, properties, and attribute values. These triples form a statement.The resources, attributes, and attribute values in the statement are called subjects, predicates, and objects, respectively.These make up the Meta-language for basic modeling.RDF Schema is used to describe the relationships between concepts and properties represented by RDF resources.

OWL（Web Ontology Language）is an ontology language used to describe metadata, which can clearly describe the concepts of terms and the relationships between terms.OWL has many more ways to represent semantic than XML or RDF.The Semantic Web uses XML to describe defined label formats, RDF to flexibly represent data, and OWL to describe the explicit meaning and relationships between terms in a document.

In general, the Internet of things does not reconstruct a physical structure, but a way of sharing thing's information based on the Internet.The information processing of things in the IoT is divided into three levels:(1) The information of the thing is labeled by a concept in the ontology and stored in the RFID electronic tag.(2) The information of the things are expressed as a standardized code, which expressed as UID or EPC codes(3) The information is uploaded to the Internet.On the operational level, the reading agent (people or machines) scattered around the world writes electronic tags of corresponding things using standardized formats as much as possible,and then develop a relatively standardized terminology bank.These terms can be found mapped in the IoT ontology.That is, a term is always in a structure and can always be described by other terms.

When a term is received by the reading agent (human or machine) whom connected to the Internet and supported by the IoT ontology, once the term coincides with another term, concept, or relationship in the ontology,then the term's semantic web will be imported, the reading agent will form an interpretation of term.Thus,the term is understood by the reading agent (human or machine).

3. THE CHALLENGES BROUGHT BY THE COGNITION OF "THINGS" TO THE DEVELOPMENT OF THE IOT

As mentioned above, the processing of "things" in the Internet of things is to give information to the "things" of physical existence.This approach is actually based on classical categorical understanding that "things" belong to different categories, either within them or outside them; all properties are binary; there are clear boundaries between categories; all the "things" in the category are the "things" as substantial being and have the equal status.With the appearance of prototype category theory, many questions have been raised about classical category theory.The current IoT technology is still based on the category theory that "things" as substantial being,which will inevitably bring a series of challenges to the development of the Internet of things at the operational level.

3.1 The Categorization Criterion Of "Things" In Iot

According to Ungerer and Schmid(1996),"This mental process of classification is commonly called categorization." (Ungerer & Schmid, 2013) From the perspective of cognition, categorization is the most basic level in human cognitive activities. Human beings classify the "things" of physical existence through their senses, and process the similar but different "things" into one category, and then form concepts and judgments in the classification of everything in the world.Concept is the range of meaning formed on the basis of category and Concept is the basis of judgment.Therefore, categorization is the basis for the formation of categories and concepts, which is the results of categorization.The process of categorization includes three forms: identification or classification, generalization and abstraction.Human beings classify sensory stimuli that belong to different categories in the process of identification or classification; human beings group together things that have common properties in the process of generalization; human beings extract the common properties of objects in a certain category In the process of abstraction.

In classical category theory, a category is discrete, where A is A, B is B, A is not B, and B is not A. Categories are defined by some features or a set of necessary and sufficient conditions. The boundary of a category is clear, and all members in this category can describe their features with a limited number of essential features.The things who meet these characteristics or conditions belong to this category, and those who do not conform to them do not belong to this category. Property is common to all category members. Lakoff (1987) once graphically summarized the category theory as "container", (Lakoff, 2008) the argues that before the publication of Wittgenstein's Philosophical Investigation, categories were always considered clear and unmistakable, like a container, with defining characteristics of things either in the category or outside the category.That is to say that classical category theory is a kind of atomized philosophical idea based on a prior guess rather than empirical study, so the categories defined in this way are discrete.

By analyzing the example of "games", Wittgenstein (1953) demonstrated that the uncertainty of category boundaries, members of a category have center and edge, and put forward the famous Family Resemblance theory:All the members of a category are connected on a set, held together by a complex network of overlapping similarities, where the similarity is sometimes a general similarity, sometimes a detailed similarity, with different situations and degrees of similarity to each other. (Wittgenstein, 1953) Since then, scholars in various fields have argued in their respective fields that the category is continuous rather than discrete, that there is no clear boundary between A and B, and that there are many transitional states.

Lotfi Zadeh (1965) initiated the concept of "fuzzy set" and applied the set theory to the study of semantic categories with fuzzy boundaries. He believed that the bounds of a set were not fixed, and the membership of elements in a set could be any real number between the two values in addition to 0 and 1. (Dawy & Songya, 2018)

Brent Berlin & Paul Kay (1969) proposed the hypothesis of focal color and basic color words through empirical research, that is, no matter what language or culture, the sequence of color words is the same: black → red → green/yellow → blue → brown → purple/pink/orange/gray.Their conclusions are as follows: (1) The focal color word is similar in any language. (2) The boundaries of color words are blurred. (3) The position of color words in a language system is not equal, there are center and edge. (4) There are 11 basic color words in human language that follows a hierarchy of implications. (Hickerson, 1971)

Through the experiment, Labov (1973) showed that it was difficult for humans to draw a clear demarcation line between vase,cup,bowl and mug according to the traditional dichotomous logic, and the boundary of categories was fuzzy. When language symbols were used to refer to objective things, their referential range was open to a certain extent.

Rosch (1973) carried out a series of experiments on focal color words based on Berlin & Kay's research on color words. Rosch replaced Berlin and Kay's "focus" with the term "prototype" to avoid the possible ambiguity caused by the word "focus".In Rosch's view, the typical colors are perceptually more salient than atypical members;typical colors are easier to remember and learn accurately than the atypical one.Later, the experiment was extended from the color category to other categories, and the results showed that the members of a category have different hierarchies of status. (Rosch, 1975)

The prototype category theory has taken shape since then. According to the view of prototype category theory, the internal members of a category are not equal, some are typical members, some are atypical members.There is only "family resemblance" among the members of a category, but not common characteristics.So the continuous category is also called the prototype category.According to Lokoff (1987), categories have a radial structure, and prototypes are located in the center of the category structure. (Rosch, 1975) Most categories present not a monocentric structure but a polycentric structure.And sometimes the members of a category have so many characteristics in common that it’s difficult to distinguish which are necessary and which is contingent.Some categories usually have multiple prototypes, which is related through the family similarity, and adjacent categories are overlap with each other.The internal structure of "center" and "edge" described by prototype category theory is suitable to describe the family similarity and ambiguity of categories.At present, there are two different understandings of "prototype" in academic circles:

The prototypes are the representation of the typical, concrete members within a category, and prototypes are instances with no marks.According to Rosch et al., The prototypes are the basic reference to determine a category and have the greatest family similarity.

The prototype is an instance that has more characteristics in common with members in the same conceptual system; a category is built around the Prototype as a reference point; The prototypes do not directly represent the marginal members of a category.The prototypes are the representation of the image schema of all members in a category, and prototypes are the average feature or central tendency of a category.The concept of "image" is used in the metaphor analysis for the first time by Lokoff & Johnson(1980) in Metaphors We Live By.Later, Lokoff (1987) combined the two terms "image" and "schema" to form the concept of "images schema". (Lakoff, 2008) The "Images" are mental mappings or projections of specific things or behaviors in the brain through people's senses.

A "schema" is an abstract description of mental mapping, which is a fixed pattern for cognition and the concept generation, and it's helpful for semantic description and reading. Langacker (1987) made a clear distinction between the two terms "prototype" and "schema". He believes that prototype is a typical instance of a category, and other members of the category are included in the same category based on their perceptual similarity to the prototype.A schema is a description of abstract features, which can completely cover or describe all the members defined by the category. (Ronald, 1987) "A schema is the commonality that emerges from distinct structures when one abstracts away from their points of difference by portraying them with lesser precision and specificity." (Langacker, 2000)To be specific, when prototype refers to "prototype instance", it only determines the basic reference of a category, and cannot directly represent the marginal members of the category.For example, sparrow can serve as the prototype of "bird", but some categories have no prototype, such as furniture, breakfast, etc. This kind of prototype like breakfast is difficult to give a broadly representative instance, but only some abstract features.A schema can consider both "typical member" and "atypical member", and has the better representation.

In general, classical category theory and prototype category theory forms the most fundamental opposition on the question of whether categories have clear boundaries.The prototype category theory holds that each member of a category is connected by the family similarity and does not satisfy a set of necessary and sufficient conditions.Category itself has the properties of fuzziness,hierarchy and openness.The prototype is the typical member of a category. As for the other members of a category, some are closer to the prototype, and some are at the edge of the category.Family similarity means that all members of a category are connected by a similar network of intersection.The members in a category have different categorical prototype based on the numbers of characteristics that the category has, just because of this the category members are not equal to each other.

3.2 The Phenomenon Of Polysemy In Iot

The previous Internet technology only realizes the information communication between people (H2H) . Under the technical conditions at that time, things themselves did not have the ability of networking.From conception to practice, the developing Internet of things technology is trying to achieve communication between people and things (H2T) & things and things (T2T).The main task of the perception-layer of the Internet of things is to collect the data of the real world. Information collection technology replaces people's senses to collect data, which constitutes a key link in the communication between the physical world and the information world.If we want to realize the ideal of global connectivity of the Internet of things, then we have to develop an information system, which poses a crucial problem:How to transform the offline physical existence as the substantial "things" into the online "things" of non-physical existence as information.

There are two main sources of data in the perception-layer:One is the active acquisition of information by devices, such as sensors, cameras and GPS, etc. Which requires active recording of the external shape of the things and tracking it's location.Therefore, there is a process of long-term interactive data collection, which requires the real-time updating of information.The other one is that the devices receive external instructions to save information passively,such as RFID, two-dimensional code(QR code) and bar code etc. Generally, the information of things are collected and stored in the database in advance, waiting to be read by the relevant agent (human or machine).The prototype category theory has already told us that the boundary of categories are fuzzy and adjacent categories are overlap with each other.Therefore, the classification criteria of "things" may be ambiguous, which will cause the identification problem of "things".

The phenomenon of polysemy in the identification of "things" on the Internet of things is inevitable.Polysemy means that a term has two or more meanings.Polysemy is an extension of the prototype category theory. In a sense, a term is a category and the different meanings of polysemy constitute the different family members in this category.Like other categories, the polysemous category also has typical and atypical meanings.A typical meaning is the first sense that comes to mind when people read this term.It's more common and to be used more often.In general, prototypical meanings/focus meanings are at the center of the category and become the "prototype" for all the family members.Because of the "family resemblance", atypical meanings develop from the prototypical meaning through different path of terms.

The significance of atypical meanings expressed are more special and narrower than the prototype one.They are at the edge of the category.Prototypical meaning is significantly higher than the atypical meanings in the polysemous category.Because of its particularity and the fuzziness at the edge of category, the atypical sense is also linked with other lexical categories.Because the atypical meanings are at the edge of the category, it is easy to overlap with other categories.Thus the term itself is ambiguous.As a result, the same "thing" has completely different meanings in different application scenarios, languages, cultures and other contexts.The premise of "things" entering into the IoT is to have a unique identification code.Just as the IP address is the unique Identification code for a network terminal in the Internet.

The number of "things" in the real world much greater than the number of terminal devices now connected to the Internet.In addition, when we want to assign a unique identification code to one thing, it's kind of like polysemy, the classification of a type of "thing" will be confused.For example, man-made products such as iPhone can be assigned to RFID by the manufacturer in the assembly line for a specific model of mobile phones, placing it under a certain category or classification system.However, when we look at the Internet of things from a global perspective beyond the level of individual companies and production plants, the same category of "things" in different language and cultural backgrounds may be divided into different category systems, which will be given completely different names, causing identification difficulties.

4. CONCLUSION

The original intention of building the Internet of things is to share information of "things" globally, which can not only be used by ordinary people, but more importantly, readable by machines for intelligent processing.Many researchers also believe that the direct challenge that the IoT facing is inherited from today's Internet. However, these challenges are magnified by the large-scale deployment of devices and services, information flows and users are swept up in the IoT. (Hachem et al., 2011)The IoT itself is opening and distributed. All the information providers located in the world can independently upload the information of "things" to the IoT network.That is to say, the IoT is generating huge amounts of data any minutes, and meanwhile there are constantly new IoT services launched and running,the knowledge database of reading agent (human or machine) will continue to expand.The traditional service discovery model based on keywords and syntax has description ability, which leads to low retrieval efficiency and difficulty for machines to understand semantic. Although the UID and EPC codes are appointed, only the standardization of the format in which information of "things" are expressed has been achieved.It's difficult to standardize the terminology at the operational level.The same kind of "things" may have completely different names under different categorical systems.If we wanna to correctly understand the information of "things" in this state, the reading agent (human or machine) receiving and processing the information from the IoT must update their background knowledge database in real time.This results in a constant lack of understanding by he reading agent (human or machine).The diversity of objects and the limitation of the subject have become the internal contradiction of IoT, which restricts the further improvement of its development.

The current common processing way to deal with the model of things is modeling the the substantial beings, thus providing a standard digital description for the things.Generally speaking, the model of things provides "normal language" for the interaction between devices, which can provide a unified and standard description of the data generated by devices, and realize the identification, analysis and sharing of massive data.Many industry standards organizations, ICT manufacturers, operators and other units are actively laying out in the field of the model of things standards.Although the dimensions of the model abstraction are basically the same, that is, the "thing" is abstracted into attributes, methods, and events in general. However, different model treats the abstraction of relationships between major elements are very different.

The data between different manufacturers and different industry organizations is not universal. The standardization of the model of things can solve the problem of normal-data among the members of the same organization in a way. But how can data be connected between different organizations and enterprises?

In the case of image technology for recognition of things, a number of techniques and algorithms have been developed.The accuracy, efficiency and range of Object recognition technology have been greatly improved, but there are still some obstacles: (1) Data acquisition.To the same thing in different perspective will get different images of thing.The background of the scene where the thing is located can cause the thing to be occluded in some way.

Background Debris has always been an important factor affecting the performance of object recognition.Many factors in the scene, such as light source, the surface color and camera, will also affect the pixel gray level of the image.It is difficult to determine the effect of various factors on the pixel gray level, which makes the image itself in many cases does not provide enough information to recover the scene. (2) Background knowledge guidance problem.The same image will produce recognition results under different background knowledge guidance.

The establishment of background knowledge database not only uses the knowledge of the thing itself, such as color, texture, shape, etc., but also needs the knowledge of the relationship between things. The effectiveness and preparation of background knowledge database directly affects the accuracy of object recognition. (3) The carrier of information.The thing itself is a carrier of high latitude information, but the thing in the image is only a two-dimensional representation of the object, and human beings have not yet understood how to recognize the object, so it can not provide direct guidance for the research of object recognition.At present, most of the visual systems established by human beings are only suitable for a specific environment or application.However, it's very difficult to build a universal visual system that can fully match human visual system.

If we want to achieve the ideal of IoT connecting everything online, it's necessary to study the classification of things and the semantic description of data and services in IoT.From the perspective of the ordinary reading agents, Users in the real world are mainly using IoT services, so the information system of IoT need to be able to understand users' needs in terms of semantics through the classification and matching algorithm to find the IoT services suitable for user's needs.It is necessary to study users' input requirements in the form of natural language, and the user's original input requirements and contextual characteristics need to be analyzed,and then to obtain a relatively universal semantic description method of user requirements, so as to establish a service model of the Internet of things.

References

Absil, P.-A., Diao, O., & Diallo, M. (2021). Assessment of COVID-19 hospitalization forecasts from a simplified SIR model. *Letters in Biomathematics.* https://doi.org/10.30707/LiB8.1.1682013528.154572

Akıncıoğlu, G., Akıncıoğlu, S., Öktem, H., & Uygur, İ. (2021). Experimental investigation on the friction characteristics of hazelnut powder reinforced brake pad. *Reports in Mechanical Engineering*, *2*(1), 23-30.
Aristotle, J. B. (1984). *The complete works of Aristotle* (Vol. 2). Princeton University Press Princeton.
Berners-Lee, T. (1998). Semantic Web Road map http://www. w3. org/DesignIssues. *Semantic. html*, *1*.
Berners-Lee, T., Hall, W., Hendler, J. A., O'Hara, K., Shadbolt, N., & Weitzner, D. J. (2006). A framework for web science. *Foundations and Trends® in Web Science*, *1*(1), 1-130.
Communities, C. o. t. E. (2009). Internet of things--An action plan for Europe. *Brussels:EC Publication.*, *2*.
Dawy, I., & Songya, T. (2018). The most general intelligent architectures of the hybrid neuro-fuzzy models. *American Journal of Artificial Intelligence*, *2*(1), 1-6.
Genesereth, M. R., & Nilsson, N. J. (2012). *Logical foundations of artificial intelligence*. Morgan Kaufmann.
Guarino, N. (1998). *Formal ontology in information systems: Proceedings of the first international conference (FOIS'98), June 6-8, Trento, Italy* (Vol. 46). IOS press.
Hachem, S., Teixeira, T., & Issarny, V. (2011). Ontologies for the internet of things. Proceedings of the 8th middleware doctoral symposium,
Hickerson, N. P. (1971). Basic color terms: their universality and evolution. In: JSTOR.
Lakoff, G. (2008). *Women, fire, and dangerous things: What categories reveal about the mind*. University of Chicago press.
Langacker, R. W. (2000). *Grammar and conceptualization* (Vol. 14). Walter de Gruyter.
McCarthy, J. (1980). Circumscription—a form of non-monotonic reasoning. *Artificial intelligence*, *13*(1-2), 27-39.
Nath, B., Reynolds, F., & Want, R. (2006). RFID technology and applications. *IEEE Pervasive computing*, *5*(1), 22-24.
Quine, W. V. O. (1948). On What There Is. *The Review of Metaphysics*, *2*(1), 21–38.
Quine, W. V. O. (1980). *From a logical point of view: Nine logico-philosophical essays*. Harvard University Press.
Ronald, W. L. (1987). Foundations of Cognitive Grammar Vol.1:Theoretical Prerequisites. *Stanford:Stanford University Press.*
Rosch, E. (1975). Cognitive representations of semantic categories. *Journal of experimental psychology: General*, *104*(3), 192.
Spiess, P., Karnouskos, S., Guinard, D., Savio, D., Baecker, O., De Souza, L. M. S., & Trifa, V. (2009). SOA-based integration of the internet of things in enterprise services. 2009 IEEE international conference on web services,
Taylor, J. R. (2003). *Linguistic categorization*. OUP Oxford.
UIT, I. T. U. (2005). ITU Internet Reports 2005: . *The Internet of things.*
Ungerer, F., & Schmid, H.-J. (2013). *An introduction to cognitive linguistics*. Routledge.
W3C Recommendation. (2014). https://www.w3.org/TR/rdf-syntax-grammar/
Wittgenstein, L. (1953). Philosophical investigation. *Oxford:Basil Blackwell.*, 47-48.