

## A CONSTRUCTION METHOD OF EMERGENCY DOMAIN ONTOLOGY BASED ON SCENARIO

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**ABSTRACT.** *Ontology is the explicitly formal specification of a sharing conceptual model. Once we build a domain ontology model, the integration and collaboration systems could be understood more easily, and make the way of sharing and reusing knowledge more smoothly. The origin and evolution of emergency domain events are complex and have scenarios dependence on events at the same time. So it has certain research value to build the emergency domain ontology modeling based on scenario. This paper presents the basic knowledge of ontology and provides a method of emergency domain ontology modeling based on scenario. Based on the above methods, the ontology of emergency domain is analyzed in detail and is constructed by using Protégé.*

**Keywords:** Emergency domain, Ontology modeling, Scenario-based, Construction method

**1. Introduction.** The function of one system is usually simple in emergency domain. Once we put the systems into integration, the linkage will produce a certain thinking ability. It has a significant impact on arrangement to deal with urban emergency events by quickly generating real-time information. To achieve the intelligence of emergency management, the main problem is to solve system semantic integration. To realize semantic integration of emergency system, ontology can be used to complete this task. As a method of conceptualizing and modeling domain knowledge, ontology can be used to describe the semantic information of data processing by the computer. It provides a shareable and conceptual specification for the domain by gaining the semantic information in emergency domain, and determining the concept of mutual recognition in this area, so that people can reuse domain knowledge in a structured way, to achieve the common understanding of information for human-computer. Because of the occurrence of emergency domain events, the complexity of the evolution mechanism and the instant scenario dependency [1], it has certain research value to build the emergency domain ontology modeling based on scenario [2].

Ontology is the most common way to represent feature models knowledge. Comparing the typical ontology construction methods, it proposes a comprehensive ontology construction method [14]. In this way, a prototype system of extracting ontology from the intelligent transportation systems has been designed and developed [15]. The core

concepts in financial management domain are given, and the ontology of financial management domain is constructed by employing Protégé [16]. A domain ontology called Scenario Object Model (SOM) is proposed, which can be used to represent the contents and structures of hazard evaluation information [17]. The proposed BESST approach provides bank stress testing stakeholders an effective method for modeling and analyzing financial crisis scenarios [2]. Dermeval conducts a controlled experiment to empirically compare two approaches based on each one of these modeling styles in several changing scenarios [18]. Yu implements the scenario ontology of earthquake with Protégé and develops a prototype system, which can retrieve some parts of scenario information and provide a visualization interface for decision makers to browse the scenario instances involved in an earthquake [12].

The current research has solved partial problem of ontology building, but there are still some existing problems: Because application systems are complex and the involved emergency domain departments are various, also lack of consistent concept basis and design patterns in the process of building ontology for the application department, emergency domain ontology building needs to form the methodology. The event has scenarios dependencies, so ontology building needs to consider according to the dynamics and extensibility based on scenario.

This paper puts forward a scenario-based method of emergency domain ontology building through analyzing the current situation and feature of emergency domain, and takes the method of building model into research using ontology technology. The building model that includes disasters-causing bodies, anti-disasters bodies and disasters-affected bodies is established innovatively, provides a reference for model building in emergency domain, and gives theoretic instruction for semantic integration, in order to systematically solve above problems.

**2. Emergency System Integration Framework Based on Scenario.** From the reality of China's emergency system, we have carried on the detailed study on the reality of the existing business application system and the basic composition and the function of each component and architecture, and put forward an ontology integration framework based on scenario.

As we can see from the framework: (1) There is a large amount of emergency information in system application layer, so it is very necessary of extracting concept to construct ontology for emergency domain ontology modeling; (2) On the basis of building the domain ontology, if we can implement the mapping between ontology and relational database, the problem of semantic integration of emergency system can be effectively solved; (3) We may achieve semantic information retrieval scenario-based for emergency system using semantic integration information to provide more information value-added services. This paper mainly studies the base layer content of the framework, which provides sources for the building of domain ontology.

**3. The Basis of Emergency Domain Ontology Building Based on Scenario.**

**3.1. The definition of the scenario.** Scenario is defined and determined by a series of status in the possible future through the probability. It has strong uncertainty, and is an extraction of each status for the possible future and a kind of possible assumption or judgment [3]. It summarizes the evolution of the event which has already taken place, and is formed by the problems refactoring of emergency management. Scenario is composed of elements. Element is the component unit of the scenario. Scenario elements are the main factors of the performance, status and trend reflecting the development status. Integrating of subjectivity and objectivity, combining of static and dynamic, and scenario element in emergency events can be designed into three constituent parts: disasters-causing bodies, disasters-affected bodies, anti-disasters bodies.

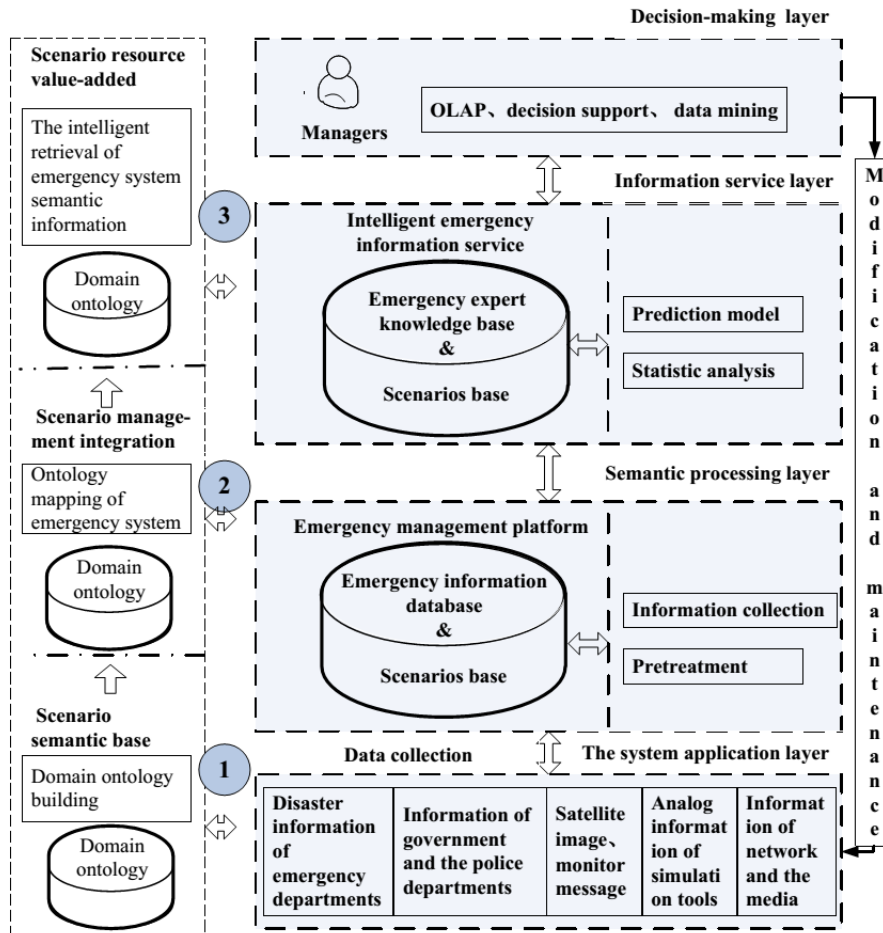


FIGURE 1. Ontology integration framework based on the scenario

3.2. **The characteristics of the emergency domain.** Building domain ontology, should not only study ontology building technology, but also have a comprehensive understanding of this field. In our country, emergency domain has complex structure, large number of sub-systems, comprehensive applications and services, so we need a common easily-extensible architecture for it. We need take a full consideration of the characteristic of emergency domain, so that ontology modeling could have its practical value.

3.3. **The definition of the ontology.** Definition given by the Stanford University Gruber has won the acceptance of many of his peers, that is, the “ontology is explicit specification of conceptualization” [4]. The definition of ontology contains four meanings: a conceptual model, explicit, formalization, and sharing [5]. These four meanings are effectively illustrated on the ontology. The ontology can describe the relations between concepts, in order to promote the sharing and reuse of knowledge and information.

3.4. **The method of building ontology.** Domain knowledge modeling is an important application of the ontology. Currently, ontology modeling method is not mature yet, and each ontology development team has its own principles, design standards and the development phase. In terms of method of ontology modeling, there is not the “absolutely right” one, and we also cannot find such an “absolutely right” one. Seven kinds of typical methods of ontology modeling are sorted by maturity as the following: seven steps, Methontology method, IDEF5 method, method of TOVE, skeleton method, SENSUS and KACTUS method. There are no relative merits of them, and each has its own characteristics. These methods are facing various needs of the ontology and should be selected according to different requirements of ontology modeling [6,7].

#### 4. The Building of Emergency Domain Ontology.

4.1. **The modeling approach of emergency domain ontology.** The building of emergency domain ontology needs to integrate the written concepts, standards, specifications and other information resources and needs to integrate information resources as much as possible within the existing system. According to the characteristics of the emergency domain itself, the design principle, the main building steps are as follows:

1) Confirm the domain and scope of the ontology: Firstly we need to build ontology covered by specific domain and application scope.

2) Collect and analyze domain information: We should fully understand the domain knowledge by collecting information by experts, books, Internet, etc.

3) Determine the important concepts and relations in the domain: After collecting and analyzing information, we need determine the important concepts and the relationships between them as the domain ontology concept set. It should meet the following two basic requirements: one is to determine the related concepts and their relationships must be domain-related; the second is to adopt the precise term to express the key concepts and relationships above [8].

4) Establish a framework of ontology: Group the concept set according to certain logic rules, in order to get a domain ontology framework.

5) Code and formalize the domain ontology: Choose appropriate ontology language to encode the domain ontology established above [9].

6) Integrate the related existing ontology: When creating the ontology, we should also find and reuse existing ontology in the domain through investigation [10].

7) Evaluate and optimize: There is no standard of ontology evaluation, but there are some basic indexes, such as the modeling principles above [11]. In addition, the building of ontology model is spirally increasing, which requires constant iterations. We can build the available ontology, and then constantly optimize them.

Extracting emergency domain ontology is one of the important tasks of building ontology. Based on the analysis of the domain, we put forward the framework of ontology building in the emergency domain as shown in Figure 2.

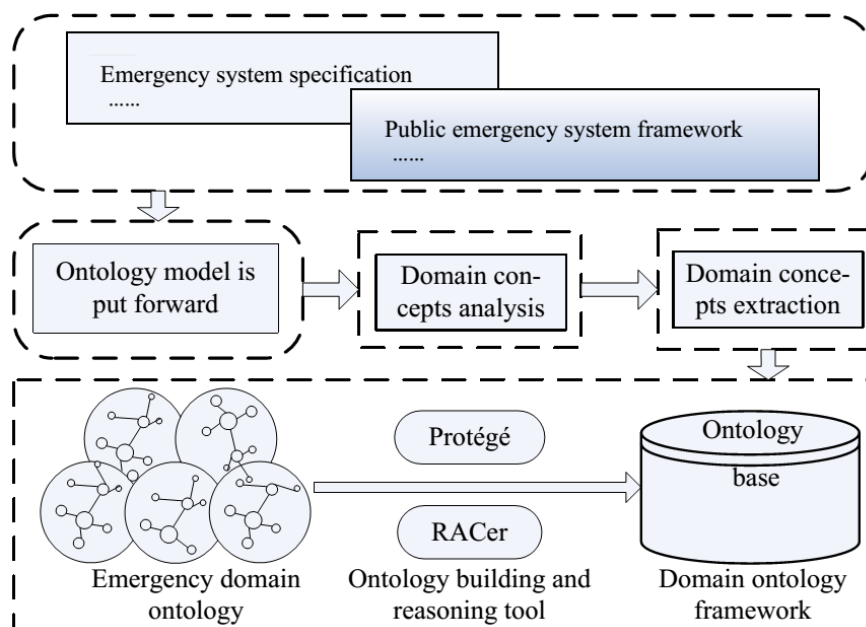


FIGURE 2. The framework of ontology building in the emergency domain

4.2. **The building of emergency domain ontology based on scenario.** In order to understand the emergency domain better, the following related definitions are given.

**Definition 4.1.** *Disasters-causing bodies: Natural factors and human factors which promote the development of emergencies event.*

**Definition 4.2.** *Anti-disasters bodies: Personnel and various resources which are used to reduce the damage of disaster in emergency event.*

**Definition 4.3.** *Disasters-affected bodies: The negative effects of People and objects due to the occurrence of disaster.*

**Definition 4.4.** *Service domains: Domains are divided according to the function of service.*

**Definition 4.5.** *Anti-disasters services: Services are provided by the anti-disasters bodies.*

According to the above definitions [12], scenario-based emergency domain ontology model is built as shown in Figure 3 [13].

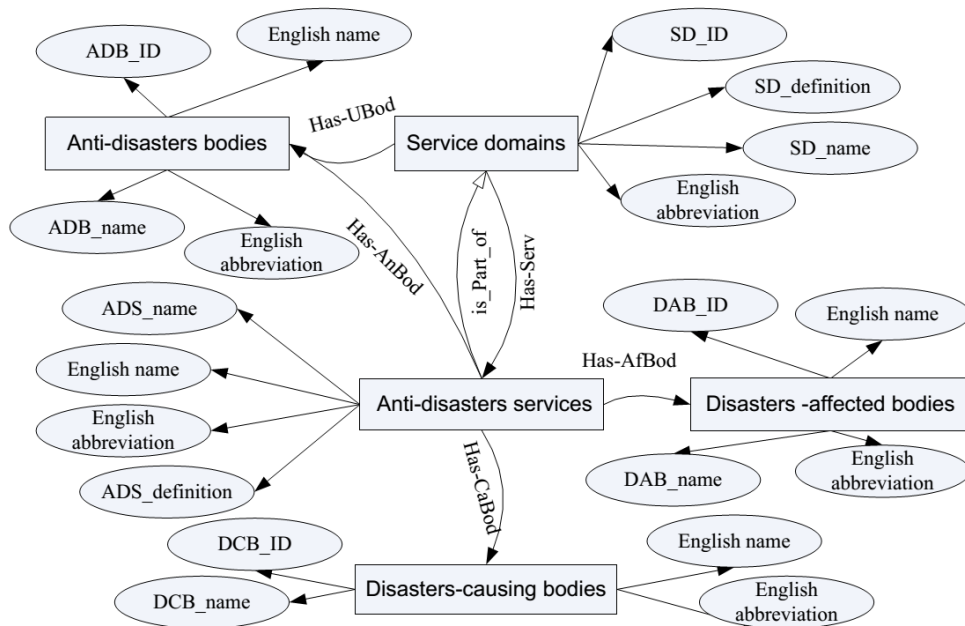


FIGURE 3. Emergency domain ontology model based on scenario

4.3. **Building emergency domain ontology using Protégé.** This paper used an ontology editing tool “Protégé” which was developed by Stanford University to build emergency services ontology. It is able to define the class and the class hierarchy, attributes, attributes’ value, attributes relationships, attribute constraints, and the relationships between classes and properties. Structure of ontology is showed with tree view allowing the user to design the domain model in conceptual level.

Structure of Figure 4 has clear layer for ontology concepts, attributes, relations of disasters-causing bodies, anti-disasters bodies, disasters-affected bodies and service domains in emergency domain. Owl file is parsed using jena in the Java environment, reasoned by RacerPro, and has certain application value to ontology building in emergency domain. The consistent relation of the concept is found through mental reasoning, which also lays the foundation for the research of the ontology mapping method in the future.

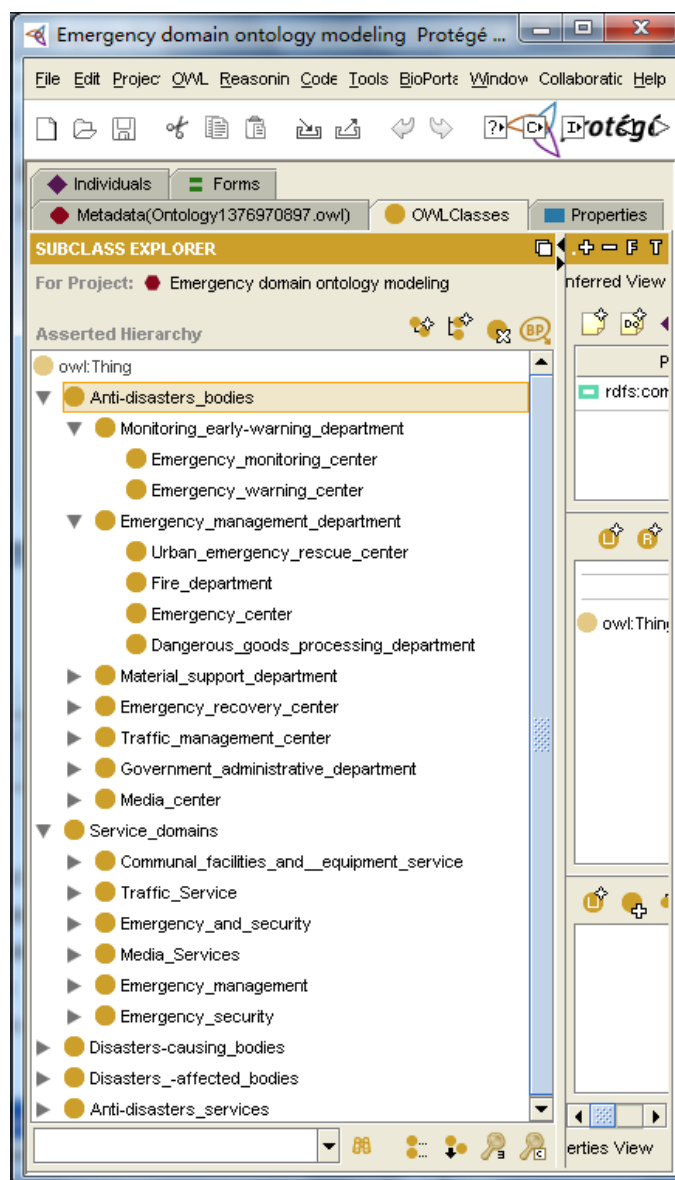


FIGURE 4. Emergency domain ontology modeling

5. **Conclusions.** In today's information age, every corner is filled with data and information. How to make full use of the needed information has been paid a lot of attention to. Ontology theory opens the door for the information sharing and reuse, and provides a strong foundation for the building of domain ontology. Therefore, this paper simply introduced the basis of ontology theory, and especially focused on how to build up simple emergency domain ontology scenario-based in the emergency domain. Research remains to be further discussed as follows:

(1) According to the characteristics of emergency domain, the research will discuss the emergency domain in different layers. Based on the characteristics of emergency domain, we will innovate the classification of thinking.

(2) Considering how to combine emergency domain ontology scenario-based with other knowledge, we will improve information sharing and reuse better.

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