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Study on Construction of Emergency Plan Ontology Model

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Abstract: On the basis of experiment of word segmentation and extraction for emergency plan, combining with meta-words of ontology, this paper extracts and classifies the core terms of emergency plan and then the concept classes, related properties and instances are established. Furthermore, the emergency plan ontology model is realized using protégé 4; By means of building the mapping relationship between meta-words of ontology and parts of OWL ontology which is verified by experiment, representation formalism of emergency plan is also realized. The general fundamental model of ontology is summarized in this experiment process and these works would provide help in knowledge representation based on ontology.

Key words: Emergency plan, ontology, model, meta-words of ontology

INTRODUCTION

At present, especially for all kinds of sudden events, lots of emergency plans have been made in most countries and areas. As the summary and conclusion of humans coping with sudden events (Mendonca *et al.*, 2003), emergency plans provides an important guidance to deal with emergency events. Taking a wide view of one thousand domestic emergency plans collected, we find that the same meaning words lack unity and plans still reserve as traditional WORD and TXT in expressive form and storage structure. Static and unstructured emergency knowledge cannot be understood directly and processed automatically by computer and this will weaken the function of assistant decision-making using computer. In order to improve present conditions, digitizing plan has been put forward and become a new research trend. Digital emergency plans could share the emergency knowledge and guide the emergency departments to cooperate well and finally will enhance effectiveness of emergency rescuing.

How to represent emergency plan effectively becomes the kernel problem of digitizing plan. Emergency plan model is the foundation of implementing digital plan (Hua *et al.*, 2009). As an important mean of describing semantic model, Ontology is definite, formalized and normative specification of shared concept model and it can offer common understanding to a certain domain knowledge and confirm the commonly approbated vocabulary. So representing emergency plan with

ontology model can satisfy the requirement of digitizing plan. Presently, there is no criterion recommended about the method of building ontology and a few mature methods, such as TOVE (Gruninger, 1996) for enterprise model process, METHONTOLOGY (Laboratorio, 1999) for chemical knowledge model, have been put forward. Some comparative analysis on several methods of establishing ontology and some beneficial suggestions are presented by Du (2005). In addition, Gruber (1995) proposed five fundamental rules to build ontology and Perez and Benjamins (1999) concluded parts of ontology to five meta-words. These will play an important role in establishing ontology model.

On the basis of result of word segmentation and extraction for one thousand emergency plans and combining the five meta-words of ontology and the thoughts of building ontology by the Stanford University, this paper will establish emergency plan ontology model using protégé 4.1 and furthermore represent the model by formal language OWL.

ESTABLISHMENT OF EMERGENCY PLAN ONTOLOGY

Components of plan ontology: In order to represent emergency plan correctly and effectively in the model, the five meta-words of ontology (concepts, relations, functions, axioms, instances), will be applied in the process of establishing plan ontology. According to this, we define the plan model as follows:

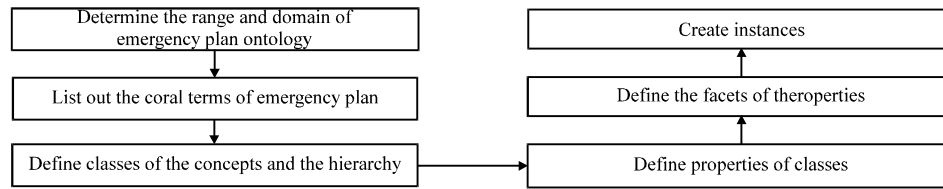


Fig. 1: Steps of constructing emergency plan ontology

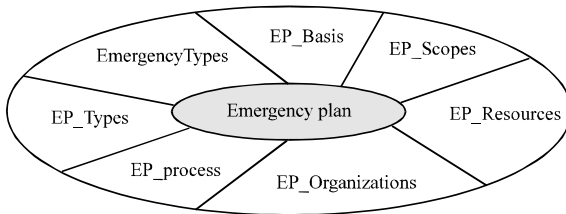


Fig. 2: First level coral terms model of emergency plan

- EP_Ontology: = <EP_Concepts, EP_Relations, EP_Functions, EP_Axioms, EP_Instances>

Namely, emergency plan ontology is defined as set function of plan concept set, relation set, function set, axiom set and instance set, of which concept set is the basis.

Steps of establishing plan ontology: Ontology is established aiming at certain domain knowledge, so firstly the range and domain should be clarified. In order to avoid repeating the same work, the domain ontology model is able to be reused and extended and before establishing new ontology, it's necessary to examine the reusability and extensibility of the existing model but in emergency field, the study on emergency plan just started not long ago, so there is no mature ontology model and this step won't be considered here; in the subsequent work, relation set, function set, axiom set and instance set are centering on concept set, so constructing the concept set is the fundamental work of realizing ontology model. According to this, steps of constructing emergency plan are summarized as in Fig. 1.

Determine the range and domain of emergency plan ontology: Emergency plan, in view of possible serious accidents and disaster and in order to develop emergency rescue action quickly, orderly, effectively and decrease the severity of casualties, property losses and environmental disruption as much as possible, is drafted in advance on the basis of analysis on the consequences

of related accidents and the abilities of emergency organizations, including emergency command organizations, emergency response, emergency recourses emergency guarantees, recovery and so on. Emergency plan ontology aims at the domain of emergency field. On the basis of experiment of building emergency knowledge dictionary based on SOM net, Emergency plan ontology will be modeled in this paper.

List out the coral terms of emergency plan: Taking the experiment of building emergency knowledge dictionary and the content of emergency plan as starting point, further analyzing the results of the experiment and the roles of emergency knowledge, we summarize the first level coral terms of emergency plan as shown in Fig. 2 and then parse these coral terms further.

Emergency Plan (EP): Emergency plan is an abstract term which summaries the rescue measures of resources scheduling, department cooperation, information publishing, etc. And it is placed in the coral conceptual level.

EP_Basis: EP_Basis is the compilation foundation of emergency plan. For example, earthquake prevention law of the PRC, emergency regulation of destructive earthquake and general emergency plan for national unexpected public accidents are the compilation foundation of the national preparatory plan for earthquake emergency. Emergency plan for serious traffic accident of Jiangsu province is compiled according to road and traffic safety law of the PRC, Emergency plan for national safety production accident, regulation of traffic safety of Jiangsu province and general emergency plan for unexpected public accidents of Jiangsu province and other rules. So we summarize EP_Basis as three sub-concepts: laws, rules and TotalEP abstractly, namely <Laws, Rules, TotalEP>.

EP_Scopes: EP_Scopes represents the scope of application of emergency plan. Each plan has its own scope of application. For example, earthquake emergency

counterplan of seismological bureau of Nanjing city is applied to the situation that seismological bureau and earthquake department cope with burst earthquake accidents in Nanjing city; emergency plan for unexpected geological hazard of Tianjin city is applied to the condition that especially serious or serious unexpected environmental emergency occurs in Tianjin or tran province (transregion, transcity) which have to be coped with and the plan conducts the guidance work to dispose the emergency. Combining with other plans, EP_Scopes includes executive areas, emergency type and emergency level which, respectively are short for EA, ET, EL, namely <EA, ET, EL>.

EP_Resources: EP_Resources represents the emergency resources involved in emergency plan which concretely consist of medical rescue staffs, project rescue staffs, medical materials, telecommunication guarantee resources, means of transport, emergency fund, emergency shelter, etc. According to the type of these resource, three abstract resources are summarized which are human resource, material resource and financial resource. A simple model can be built as EP_Resources = <HumanRes, _CmaterialRes: _CFinancialRes >, of which HumanRes is short for human resource, MaterialRes short for material resource, FinancialRes short for financial resource.

EP_Organizations: EP_Organizations represents the organizations in the emergency command system, Such as national or provincial seismological bureau, power bureau, government, commander in chief etc. EP_Organizations is a special concept in emergency plan and the list of commanding organizations and guiders must be enumerated clearly. These are summarized as follows: _FGovernment, Department, Directors, Specialists. A model can also be built as EP_Organizations = < Gov, Dep, Directors, Specialists >, of which the four parts are corresponding to the former four organizations.

EP_Process: EP_Process represents the process of coping with emergency accidents. In accordance with the normal development of the incident, emergency process is conceptualized as emergency forecast (E_Forecast for short), emergency alarm (E_Alarm), emergency respond (E_Respond), emergency guarantee (E_Guarantee) and later disposal (Later_Dispose). The process is a dynamic one which is an independent study field and not to research further here. The plan ontology will show the related organizations and their duties in every stage.

EP_Types: EP_Types represents the type of emergency plan. Basing on the role and application scope of plan, six types are divided which include general EP (GeneralEP), special EP (SpecialEP), department EP (DepEP), local EP (LocalEP), enterprise EP (EnterpriseEP) and important event EP (ImportantEP).

Emergency types: EmergencyTypes represents the type of emergency events. By means of analysis on the types of emergency accident involved in a thousand emergency plans and reference on the explanation of emergency events on official websites, we get four event types that contains natural disaster, accident disaster, public health event and social safety event. Each type can be made multi-layer division, for example, the concept of natural disaster could be divided into drought and flood, meteorological disaster, geological hazard, marine disaster, biological disaster, etc. In addition: _CEP_other is defined for other concepts of emergency plan, such as purpose and principle of compilation and the supplementary articles, etc.

Integrating the concepts and sub-concepts above, we build the concept model of meta-word of emergency plan ontology as follows:

- EP_Concepts=<EP,EP_Basis,EP_Scopes,EP_Resources,EP_Organizations,EP_Process
- _CEP_Types, EmergencyTypes, EP_Others>

Define classes of the concepts and the hierarchy: According to the analysis on corresponding concepts above, the structure of concept system of emergency plan is constructed by the method of top-down as Fig. 3 shown. Because of the length of paper, the first two levels just are displayed and more levels will be seen in the structure of concept hierarchy which is built by protégé 4.1.

Define properties of classes: The classes of the concepts and the hierarchy just show the frame structure of the concept of emergency plan and the inheritance relationship of concept classes. On the basis of the classes defined above, the main task of this part is to define the corresponding properties of the classes. In order to better express the emergency plan with OWL, the main form of relationship is defined as 'Is...' or 'Has...', for example, Generalplan 'is-a' kind of EP_Types; E_Forecast 'IsPartOf' EP_Process; EP 'HasEmergencyOrgs' Directors; EP 'HasResource' EP_Resources. Some properties have practical

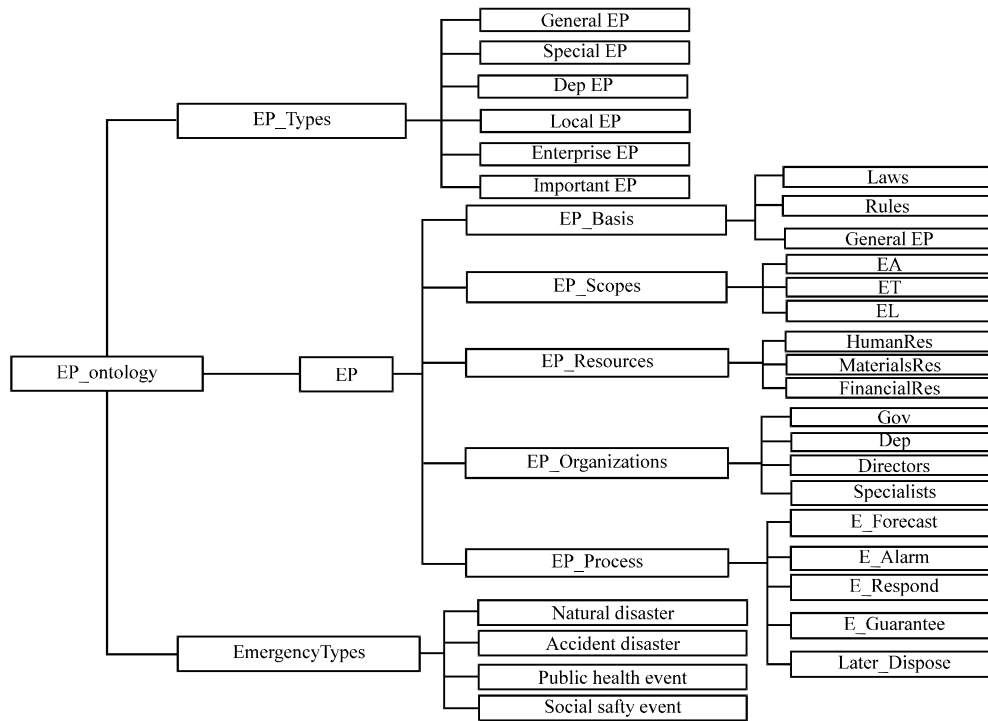


Fig. 3: The classes and hierarchy structure of emergency plan

significance, for example, emergency plan ‘AccordingTo’ EP_Basis; EP ‘ApplyTo’ EP_Scopes. And the class itself and its instances are expressed with concrete data properties and the corresponding data, such as EP_title, EP_Purpose, EP_Principle, EP_Creator, etc.

Analyzing on relationship properties, we classify the relationship into three kinds which are Father-Son, Whole-Part and Special-Function:

- Father-son relationship: namely the relationship of subclass inheriting parent class, such as ‘Is-a’, law ‘Is-a’ EP_Basis, HumanRes ‘Is-a’ EP_Resources
- Whole-part relationship: Namely the relationship of whole and part, such as ‘Has---’, EP_Organization ‘HasGov’ Jiangsu provincial government
- Special-Function relationship: it represents the special function relationship between different concepts in emergency plan, such as ‘lead’, ‘command’, ‘apply to’, ‘locatein’

These relationships are corresponding to the relation of meta-words of emergency plan ontology and a simple model can be established as follows: EP_Relations=<Father-Son, Whole-Part, Special-Function>.

Define the facets of the properties: The task of this part is to split the facets of related characteristics of the

properties associated with the concept classes in emergency plan. The property is divided into two types and one is object property which describes the relationship between classes or instances, the other is data property which describes a single class or individual. For the data property, the facets can be used to describe the type, range and amount of value and for the object property, the facets can be used to display whether the property owns the characteristics of functional, transitive, symmetric, reflexive, etc., And these can all be shown in the process of building ontology with protégé 4.1. For example, for the property of ‘According to’, its domain is the class ‘EP’ and its range is the class ‘EP_basis’ and the type of emergency event level is set as ‘integer’.

Create instances: The class is instantiated in this part. Its rule is that according to lexical library which is made up by the result of extraction and segmentation for emergency plan. Lots of instances will be set by properties and values and knowledge base of emergency plan will be created. The instances created make up of the content of EP_Instances of ontology meta-word.

Realization of EP ontology model: EP ontology model is the abstract description of semantic knowledge of emergency plan and will be realized with protégé 4.1 and OWL that describes ontology. There are four important

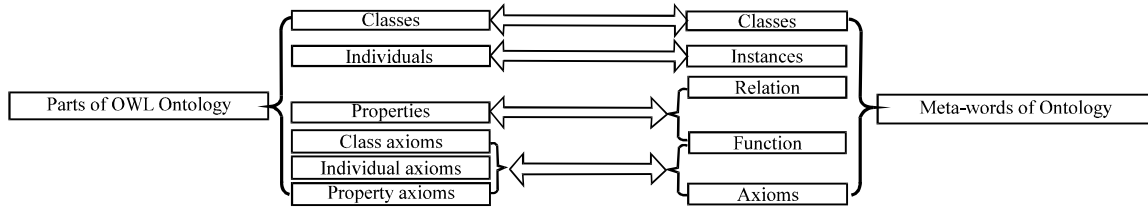


Fig. 4: The mapping relationship between parts of OWL ontology and meta-words of ontology

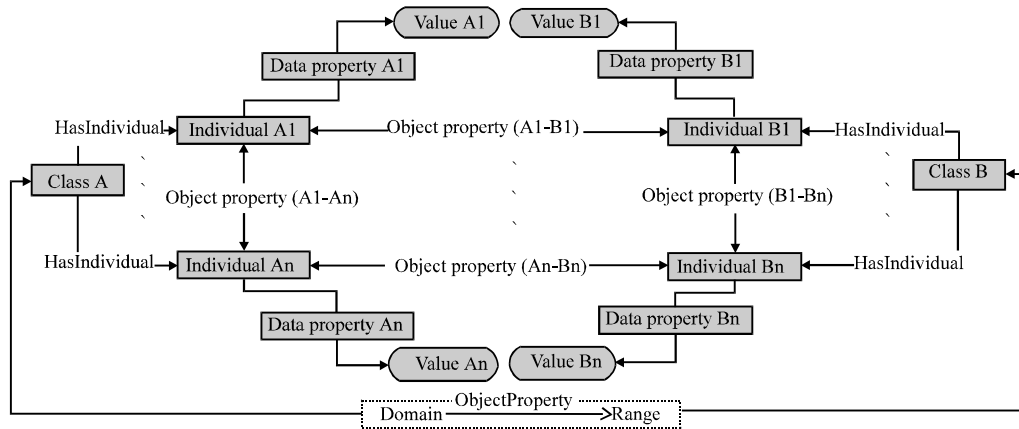


Fig. 5: The fundamental model of OWL ontology

parts in the OWL ontology model which are Classes, Individuals, Properties and Axioms. And Axioms can also be divided concretely into Class axiom, Individuals axioms and Property axiom. The mapping relationship between parts of OWL ontology and meta-words of ontology is an important basis of establishment of EP ontology and the Fig. 4 shows the mapping relationship.

Of these parts of OWL ontology, 'Class axioms' contains 'SubClassOf', 'EquivalentClass' and 'Disjointwith'; 'Individual axioms' includes 'SameAs' meaning the relationship of two individuals representing the same thing, 'DifferentFrom' meaning the relationship of two URIs pointing to different individuals and 'AllDifferent' meaning the individuals in the list are different from each other; 'Property axioms' is composed of domain, ranges, Functional, Inverse functional, Transitive, Symmetric, etc. These axioms play an important role in expressing ontology correctly and reasoning efficiently.

Fundamental model of realizing EP ontology: According to the mapping relationship above, emergency plan OWL ontology can be easily fulfilled. After building the classes, we create individuals and some object

properties centering around each class and then establish the other object properties, data properties and values centering around each individual. For example, class 'EP' has an individual 'EP for earthquake of Nanjing city' and class 'Directors', the subclass of 'EP_Organizations', has an individual 'headquarters of earthquake', then these two individuals can be connected with objectproperty 'HasEmergencyOrgs'. And for the individual 'headquarters of earthquake', the dataproperty 'components', 'duty' and the corresponding value can better describe it concretely. According to this, a fundamental model can be established as shown in Fig. 5 shown.

Visualization display of emergency plan: Basing on the work above, the visualization of emergency plan will be realized by the plug-in 'OntoGraf' of protégé 4.1. OntoGraf displays not only the hierarchical structure of concept classes but the instances of classes and the objectproperties and it is beneficial to understand the whole structure of ontology quickly for the readers. Because of the length of paper, the visualization of ontology is intercepted partly as shown Fig. 6.

Fig. 6: Structure of EP ontology model (partly). Remarks: different color line represents different associated relationship and concept classes start with ●, individuals with ◆

CONCLUSION

By means of the five meta-words of ontology, we build the ontology model of emergency plan. The kernel concepts of emergency plan are classified and centering around each class, the relationship properties, individuals and restrictive conditions are also be studied and built. On the basis of building mapping relationship between metawords of ontology and parts of OWL ontology, the visualization of emergency plan ontology is realized. But some problems are also found in the process of establishing the emergency plan.

- There is no explicit dictionary of emergency knowledge about emergency plan and this brings lots of difficulties in abstractly summarizing knowledge concepts and keeping the consistency of concepts
- There is no normal template to standardize emergency plan. Different executive-level plan has different degree of standardization which brings lots of inconvenience to the design and realization of sharing model
- Some plug-ins of protégé 4.1 can not support Chinese well enough

Digitizing emergency plan still needs lots of work to do and we will research the problems above further in our future work and wish to be able to push forward the development of Digitizing emergency plan.

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