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Approach for analyzing, extracting and modeling e-government ontology

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Abstract: Taking the knowledge-intensive characteristics of governmental processes into account, an approach to analyzing, extracting and modeling e-government ontology by using both the IDEF5 ontology capture method and the web ontology language (OWL), is presented. First, both knowledge-intensive activities and knowledge items can be identified by the analysis of governmental processes. Secondly, the IDEF5 ontology capture method is utilized to extract concepts, terms and statements from these knowledge items, which act as a starting point for ontology refinement and validation. To describe precisely the semantics of the ontologies, the OWL language is employed in our project to formally model these e-government ontologies with the help of Protége-OWL tools. Finally, a case study about applying for social security cards (SSCs) in Shanghai local government is illustrated to demonstrate the effectiveness of the presented approach.

Key words: e-government; ontology modeling; OWL; IDEF5

Electronic government aims at enhancing efficiencies of government services, reducing operational costs and improving quality of services[1]. It is estimated that 85 percent of countries around the world have undertaken to implement e-government strategies and rank them as one of the top priorities in their countries. With the popularity of electronic government, much research effort focuses on the e-government domain[1]. Different from electronic commerce, a distinguishing characteristic of e-government is that government processes belong to knowledge-intensive business processes. The reason for this is that most tasks or activities involved in governmental processes rely on knowledge such as documents, forms and rules to make decisions. As a result, much attention is attached to the application of knowledge management in e-government with the aim of building an intelligent, modern government and thus improving the handling efficiencies of government services[2-3]. A wide range of research projects related to knowledge management within e-government has primarily concentrated on the construction of a knowledge management system (KMS) or knowledge management platform for government departments[4-5]. Most of these projects, except the SmartGov, adopted the document-based approach to constructing an e-government KMS. Recently, the ontology-based approach[6] for building knowledge management platforms or KMSs has been widely accepted since ontology[7] offers a precise, structured representation of domain concepts, relationships, properties and axioms among them. Different from business processes within enterprises, most e-government processes such as low-income aids applications, law cases handling possess knowledge-intensive characteristics[8] since some tasks within these processes make heavy use of knowledge assets to make decisions. Taking the knowledge-intensive characteristics of e-government administrative processes into account, we present an ontology-based approach for building e-government KBSs through the combination of the IDEF5 ontology capture method[9] and the OWL (web ontology language)[10].

1 Ontology-Based E-Government Knowledge Modeling

By combining the IDEF5 ontology capture method and the OWL, we present an ontology-based knowledge modeling approach for e-government: ① Governmental processes are analyzed in accordance with the process modeling methods such as unified modeling language (UML) activity diagram[11]. Therefore, both the knowledge-intensive tasks within these processes and the knowledge items that these tasks heavily depend on can be identified. ② The IDEF5 ontology capture method is employed to extract the concepts, properties and relationships from these identified knowledge items. As a result, a rough domain ontology for e-government application can be structured. ③ The OWL, the ontology web language with DL-based semantics, is then adopted to formally represent the domain ontologies to give them well-defined semantics, thereby enabling the reasoning about concept inconsistencies. ④ The e-government knowledge base can be built by in-

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stantiating these domain ontologies, which act as a foundation for implementing an e-government KMS. Fig. 1 shows the presented approach for e-government knowledge modeling consisting of the above five phases.

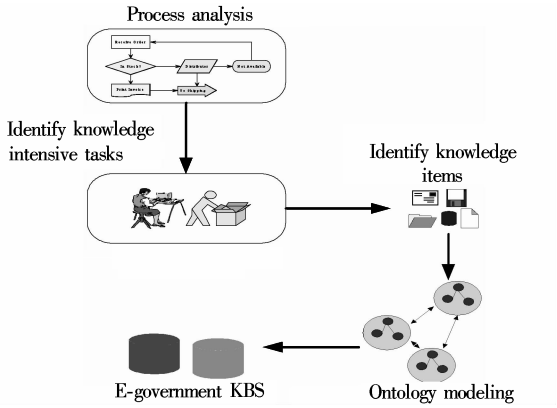

Fig. 1 A framework for analyzing domain ontology

2 Analysis of Government Processes

Government processes such as applying for low-income aid typically are knowledge-intensive processes as some activities within these processes rely heavily on knowledge such as regulations and rules to make decisions. To formally represent process models is crucial for analysis of government processes. Currently, there exist a variety of modeling approaches, ranging from graphical notations (such as EPC) to formal techniques (such as Petri-net). As a standard modeling language, UML[12] offers various notations for modelers to depict static and dynamic behaviors of systems. With graphical notations and the support from a wide range of existing tools, UML has been widely adopted by software engineering communities and practitioners as a means to analyze, model and develop applications. Amongst these UML notations, the UML activity diagram has been used in process modeling and workflow modeling due to the richer constructs offered, such as concurrency, split, and synchronization. We utilize the UML 2.0 activity diagram in our project to model knowledge-intensive e-government processes.

3 Identification of Knowledge-Intensive Tasks and Items

Based on UML-based process models, we can further analyze the inputs, outputs of activities and knowledge items on which the activities depend. Through this analysis both knowledge-intensive tasks and knowledge items are identified. Additionally, forms, availability and sources of knowledge items can be determined. For identified knowledge items (such as regulations and rules) in the form of electronic documents, databases, etc., the IDEF 5 ontology capture method is utilized in our project to extract key concepts and properties from them. The main meta-concepts used in the IDEF5 are *Kind*, *Property*, and *Relation* where *Kind* represents concepts or entities, *Property* indicates the characteristics of entities, *Relation* means the relationships existing between the entities. By applying the IDEF5 ontology capture method, we can identify a rough domain ontology for the e-government domain. Fig. 2 shows the relationships between documented knowledge items, knowledge terms and knowledge statements within the IDEF5 ontology capture method.

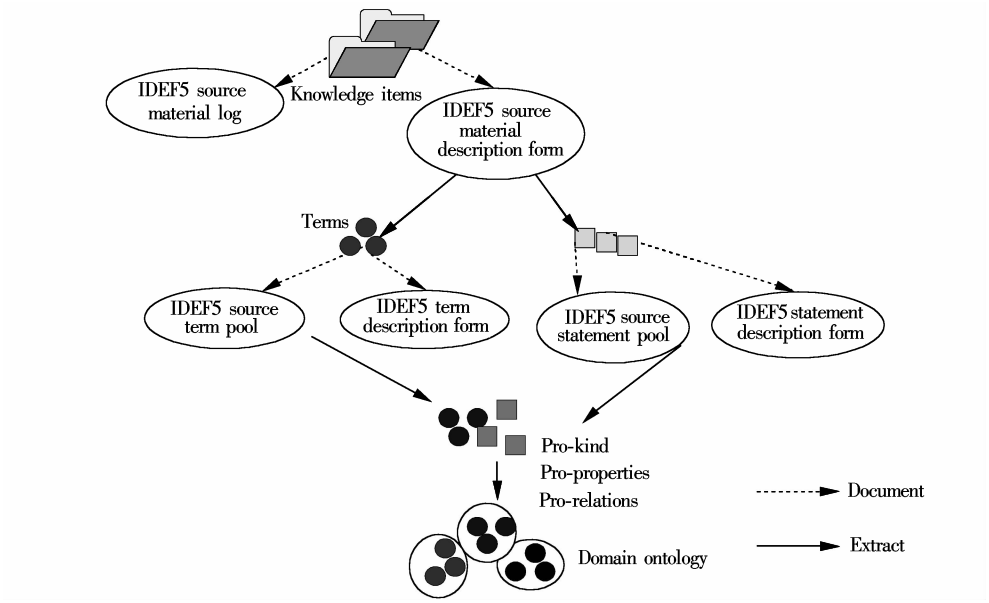

Fig. 2 IDEF5 ontology capture method

4 Formal Modeling Ontology

Formal representation of ontologies is crucial to giving them well-defined semantics, thereby enabling the reasoning about concept inconsistencies. We adopt the OWL to formally define the concepts, properties and relationships that have been extracted in the earlier phases. A main advantage of using OWL is to enable automatic reasoning about inconsistencies owing to its DL-based semantics. Additionally, a range of existing tools such as Protége and Jena can be used to manipulate OWL-based ontologies and knowledge bases.

5 Case Study

To illustrate the analysis of knowledge-intensive tasks within e-government processes using the presented approach, we describe a scenario based on the issue of social security cards (SSC) in Shanghai local government.

5.1 Process analysis

The process of granting an SSC for legitimate citizens in Shanghai is operated as follows. A citizen travels to the nearest SSC community branch office (CBO) where social workers check the availability of information on his/her residence certificate (may be delayed due to other factors) in the CIS (Shanghai citizen information system). If it is not ok, the process ends. Otherwise, he/she needs to fill in an application form containing information on labor employment, housing benefits, and health insurances in order to apply for an SSC. Social workers in the CBO then verify consistencies between the data on this form and those in the CIS. Additional paper-based proofs are required to be presented for updating these data and ensuring their integrity when inconsistencies are detected. If ok, the application is assessed in accordance with legal rules or regulations. After its approval, the tasks of taking pictures and fingerprint impressions, and making payment can be done sequentially. Finally, the data contained on the form are transferred to the SSC center to make cards which typically take about one or two months. The finished cards can be mailed to citizens or wait to be picked up by citizens personally. The entire process involves several government agencies, namely, the community CBO, the Shanghai SSC center and the CIS.

5.2 Knowledge items and extract of concepts

As mentioned above, the knowledge-intensive tasks are those that make heavy use of various knowledge items such as regulations and policies to make decisions. From the process model of applying for an SSC, we can conclude that the knowledge items on which the task "assessment of the SSC application" relies are the Shanghai SSC policy and the Shanghai SSC supplement where essential rules are specified for applying for an SSC. An example rule states that persons older than 18 can apply for SSCs. With the IDEF5, the identified knowledge items in our project are documented in both an IDEF5 source material log and an IDEF5 source material description form, thereby creating a traceable link between knowledge units (such as concepts) and knowledge sources. Then, key domain concepts and vocabularies can be extracted from these knowledge items by using an IDEF5 term pool and term description form, thus forming an essential foundation for ontology refinement and e-government ontology modeling.

Based on the concepts and statements identified above, the e-government ontologies within our project are hierarchically constructed to support the reuse of domain concepts and terms across various e-government applications. The e-government ontologies are classified into three parts: general ontology, domain ontology and application ontology. The general ontology contains generic concepts shared by all domains, such as location, time, event, state. The domain ontology includes the terms and vocabularies specific to the e-government domain, for example, GovDocument, GovService, citizen, credentials. In addition to including ontologies from the domain ontology, the application ontology also defines methods-specific or task-specific concepts required to solve an application problem. The terms SSC application form, SSC decisions are such ontologies. Fig. 3 shows the partial taxonomy of the e-government application ontologies in our project.

6 Conclusion and Future Research

Building a knowledge management system for e-government is an effective means to improve the efficiencies of handling government services and reducing the operational costs of government agencies. In this paper, we present an approach for analyzing, extracting and modeling e-government ontology using both the IDEF5 ontology capture method and the OWL. A case study about applying for an SSC in Shanghai local government is illustrated to demonstrate the effectiveness of the presented approach. Future work will concentrate on the representation of government rules in the SWRL (semantic web rule language) and on the development of rule-based KBS using JESS.

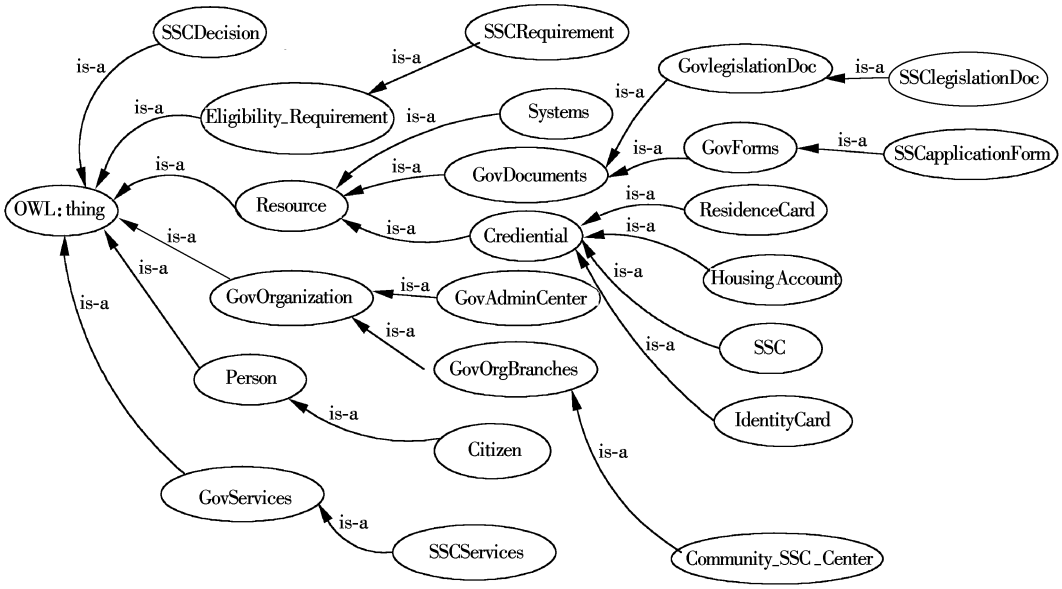

Fig. 3 A taxonomy of domain ontology within e-government

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一种电子政务本体的分析、获取和表示方法

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摘要:针对电子政务流程的知识密集型特点,提出一个采用 IDEF5 本体获取方法和 OWL 语言来分析、抽取和建模电子政务领域本体的途径. 首先,通过对电子政务流程的分析,能够识别知识密集型活动和知识项. 然后,应用 IDEF5 本体获取所识别的知识项中抽取电子政务领域概念、术语,从而作为精化和验证领域本体的基础. 并采用了 OWL 来形式化表示这些领域本体,从而使其具有良好定义的描述逻辑语义. 最后,以上海市政府的社会保障卡申请流程为例,论证了所提方法的有效性.

关键词:电子政府;本体建模;OWL;IDEF5

中图分类号:TP18