

A Framework for Knowledge Service Based on Concept Knowledge Tree

Zhihui SHEN¹, Zaijiang YUAN²

¹The Second Artillery Engineering Institute, Xi'an, China

²High Technology Institute of the Second Artillery, Beijing, China

Email: shenzhihui-2002@163.com

Abstract: Knowledge service is the integration of knowledge and services, in which knowledge serves as a resource to be provided for consumers to meet their requirements for diversified, specialized and personalized knowledge. Based on traditional knowledge service methods, a concept knowledge tree based on modelling framework for knowledge service is proposed in this paper, which includes knowledge resource model, user requirement model and service model. Knowledge resource model is used to complete the package of knowledge resources by semantic representation and organization, while user requirement model is designed to capture user interest pattern, and service model plays a role in linking knowledge resources and user requirements. After that the knowledge service application architecture is described.

Keywords: concept knowledge tree; knowledge service; user requirement model;

1 Introduction

Knowledge has become one of the most valuable resources in modern organizations. Knowledge service is a service process to satisfy the users' requirement of knowledge. Based on the searching, analysis and integration of knowledge resources, knowledge services can provide users with physical knowledge products or some intangibles, such as concepts, models and so on. It can organize knowledge dynamically and deliver knowledge accurately according to users requirements.

Nowadays, with the rapid development of IT, experts and scholars at home and abroad pay special attention to the knowledge services technology. Some papers have made special presentations and researches on it. For example, the concept of Knowledge Grid was proposed for the vision of knowledge sharing and knowledge services. M.Cannataro developed architecture for distributed high performance knowledge discovery applications in paper "Knowledge Grid", in which the knowledge grid services are organized in two hierarchic levels: Core K-grid layer and High level K-grid layer. And it's implemented on top of Globus to offer distributed knowledge discovery services [1,2]. D.Talia summarized the knowledge grid service framework and the design mind of VEGA, and proposed a grid based distributed knowledge discovery system [3]. Yike Guo et al. designed a knowledge discovery application architecture in Discovery Net Project, including resource discovery server, knowledge server and meta-information server [4]. A Service-Oriented Knowledge Architecture based on OGSA and Semantic Grid has been proposed to provide knowledge support for distributed computing in Geodise project [5].

The KB-Grid research group in Zhejiang University provides knowledge services through building large-scale knowledge systems based on ontology and Semantic Web [6]. Zeng Qinghua and Fu Ning etc. in National Defense University propose a kind of knowledge service (Knowledge on demand, KOD) mechanism in the strategy simulation system, by which effectively increases the activeness and intelligence of service [7]. Ren Yan in University of Defense Technology has done in-depth research on knowledge service modelling of C2 (command and control) under the conditions of network-centric warfare, and presents a multi-perspective Knowledge Service Description Model (KSDM) [8,9]. Xia LI analyses and defines the notions and functions of the knowledge service platform [10]. Z.C. Yu constructs a knowledge service framework for satisfying enterprises' knowledge demand [11].

Based on the above researches, a concept knowledge tree based modelling framework for knowledge service is proposed in this paper. The concept knowledge tree not only has good structural performance and high representative ability, but also good flexibility and extensivity in practice. Through the establishment of knowledge resources model, user requirements model and service model, a user-oriented knowledge service mechanism is presented, which aims to improve the efficiency and satisfaction of service.

This paper is structured as follows. In section 2, the essential description of the concept knowledge tree is expounded. Section 3 presents the proposed knowledge service framework in detail and designs the application architecture for knowledge service. In section 4, we make a conclusion and discuss our future work.

2 The Structure and the Mechanism of Concept Knowledge Tree

Concept knowledge tree is an ontology based and multi domain-oriented knowledge representation architecture for the purpose of solving problems in artificial intelligence, such as knowledge acquisition, semantic processing, rule-based reasoning etc [12]. The semantic representation architecture is constructed of three parts, which are knowledge ontology model, knowledge tree model and semantic compound model.

Concept is used as the atomic semantic unit of meaning in the knowledge ontology model. A concept is characterized by three key elements: (Attribute, Relationship, Behaviour), where attribute reveals the intrinsic characteristics of a concept; Relationship indicates the inter-connection between concepts according to certain principles; Behaviour shows the operation (action) imposed on or received from other concepts. An attribute reveals the intension of an concept and is represented as a duple (AttrName, AttrValue) where “AttrName” is the identifier of the attribute, and “AttrValue” is the value of the attribute.

Three relationships which are parent-son, whole-part and semantic field are defined under the concept knowledge tree framework. Parent-son describes the inherit relation between two concepts. Whole-part describes the membership relation between two concepts. And Semantic field is used to compare the similarity degree of one concept to the referenced concept in a related (synonymous, antonymous, ordinal, etc.) concept collection. A behaviour, whose form is a small list of code called script, is used to depict the action activated by the case that the concept’s attribute or relationship accords with some special conditions.

Knowledge tree model is used to describe the high-level semantic classification of knowledge on the basis of concepts, which is shown in Figure 1. It’s constructed of knowledge nodes, in which each node in the trees denotes a domain specific concept and each tree provides a hierarchy of the nodes in it.

The semantic compound model shows that multiple independent concepts could compose one compound concept by certain principles, including the following three kinds of compounding rules:

- Mean-Binding: If a concept A is an attribute of concept B, then they will be combined, and A becomes the value of the attribute of B. Concept A is called Bind and B is called Core.
- Mean-State: A series of concepts, in which there is an action concept as nominative, can compose a compound concept which depicts an event or state. The nominative here is called Predicate concept which is often composed by concepts of verb or adjective.

- Mean-Logic: A list of concepts can compose one concept with logic predicates such as “and”, “or”, “not” etc.

By these three principles, smaller concepts can compose compound concepts recursively.

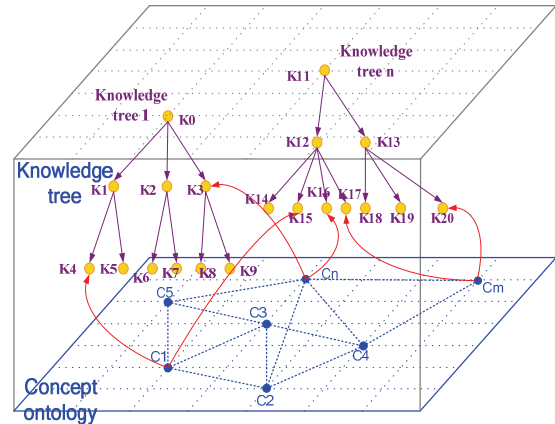


Figure 1. Knowledge tree model

3 Knowledge Service Model Framework Based on Concept Knowledge Tree

Knowledge service is a service process to satisfy the users’ requirement of knowledge by packaging knowledge resources and fully understanding the requirement of users. Therefore, the knowledge service model should consist of three parts which are Knowledge Resources Model (KRM), User Requirement Model (URM) and Service Model (SM). They are described in detail as follows:

3.1 Knowledge Resources Model

A knowledge resources model can be represented as

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<KRM> ::= <Domain, KnowTree, Concepts >.
<Domain> ::= <Domain_name>
<KnowTree> ::= <KnowTree-Name, TopNode>
<KnowTree-Name> ::= <String>
<TopNode> ::= <KnowNode>
<KnowNode> ::= <Serial, KnowNode-Name, KnowNode-Meaning, [Parent] [Child] [Belong] [Member] [Behavior]>
<KnowNode-Meaning> ::= <Semantic-Representation>
<Semantic-Representation> ::= <Concept> | <Semantic-Bind> | <Semantic-State> | <Semantic-Logic>
<Concept> ::= <Define, Attribute-List, Semantic-Relation>
<Attribute-List> ::= <Attribute>
<Semantic-Relation> ::= <Semantic-Field>
<Attribute> ::= <Attribute-Name, Attribute-Value>
<Semantic-Bind> ::= <Bind, Core>
<Semantic-State> ::= [ <Subject> ] <Predicate-Concept> [ <Object-L> ] [ <State-List> ]
    
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<Semantic-Logic>::=<Logic-Operator, Logic-Parameter>
<Logic-Operator>::=<AND>|<OR>|<NOT>|<XOR>
<Behaviour>::=<Rule>
<Rule>::=<Rule-Name, Precondition, Conclusion>
  
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3.2 User Requirement Model

An user requirement model can be represented as

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<URM>::=< Client_info, Service sets, Service history, Preferences >
<Client_info >::=<Client ID, Client name, Client password, Client, Client age, Client contact>< Service sets >::=< time, sets>
< sets>::=<{set(i)|i=1...n}>
< set(i)>::=<KS_id, Se, Sp>
  
```

<Preferences>::=<interface preferences, interactivity preferences, media type preferences, content type preferences, interactivity level preferences>

set(i) represents the details of the service used. KS_id is used to describe knowledge service identification, Se is used to describe knowledge service mode and Sp means knowledge service method provided.

3.3 Service Model

A service model can be represented as

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<SM>::=<Meta_info, In, Out, Configuration, Service Content >
<Meta_info>::=<Name, Creator, Subject, Introduction, Date[other information]>
<In>::=<Properties, Request>
<Properties>::=<Name, Importance, Contact_info, Links[others]>
<Request>::=<Recommendation, Plan request, Knowledge Providing request, [other requests]>
<Out>::=<Content, Style>
<Content>::=<Graph, E-mail, Sheet, List, Hyperlink [other type]>
<Configuration>::=<Environment parameters, Service type,[other parameters]>
<Service content>::=<Service unit>
<Service unit>::=<KEM,URM>
  
```

Meta_info is used to define the basic information about a service such as service name, service creator, service subject, simplified description, creation date, etc. In and Out represent the interfaces of a service. In is used to describe properties and requirements of users and out is used to set the output results of a service and their styles. Configuration is used to set parameters of requirement environment and service style. Service content is used to describe the specific knowledge services content.

3.4 Knowledge Service Application Architecture

Based on the above analysis, a knowledge service architecture based on the concept knowledge tree is

proposed as shown in Figure 2. User requirement model is used to capture the user's interest and discover the approach pattern. Knowledge resource model is used to organize and represent knowledge resources, and achieve the semantic description of resources by semantic annotation and semantic indexing, which finally achieves the purpose of knowledge packaging. Service model plays a role in linking knowledge resources and user requirements. On one hand it can provide knowledge services management, such as service description, registration, cancellation of management. On the other hand it can provide the semantic matching between knowledge resources and user requirements. The knowledge management tool can directly be used for creating, updating and using concept bases and knowledge trees.

There are four patterns of knowledge service as following:

Knowledge search service. It can provide user with semantic search results by semantic analysis of user's queries based on concept knowledge tree, which includes the conceptual serialization of queries, semantic matching and results ranking.

Knowledge navigation service. It shows users the positions of specific knowledge by means of classified catalogue, knowledge map, and search engine, etc.

Knowledge recommendation service. It can push knowledge to users through pre-treatment of filtering, classification, ordering, combination, reconstruction etc., according to knowledge individualization configuration of knowledge customization service.

Knowledge customization service, namely the knowledge personalized customization. It can integrate and refine professional knowledge to meet the personalized requirements of users'.

4 Conclusions and Future Works

In this paper, we presented a framework based on concept knowledge tree for knowledge service. We analysed the existing knowledge service methods and gave a brief introduction about concept knowledge tree. We suggested a knowledge service model, which consists of knowledge resources model, user requirement model and service model. And we also proposed a kind of knowledge service application architecture.

There are still some issues left to be investigated. First, the uncertainty and dynamic of user requirements makes it difficult to capture the user's interest pattern accurately. Another valuable issue, which could introduce successful learning algorithms, is to seek an efficient automatic or semiautomatic method of constructing the knowledge nodes to organize and represent the knowledge resources.

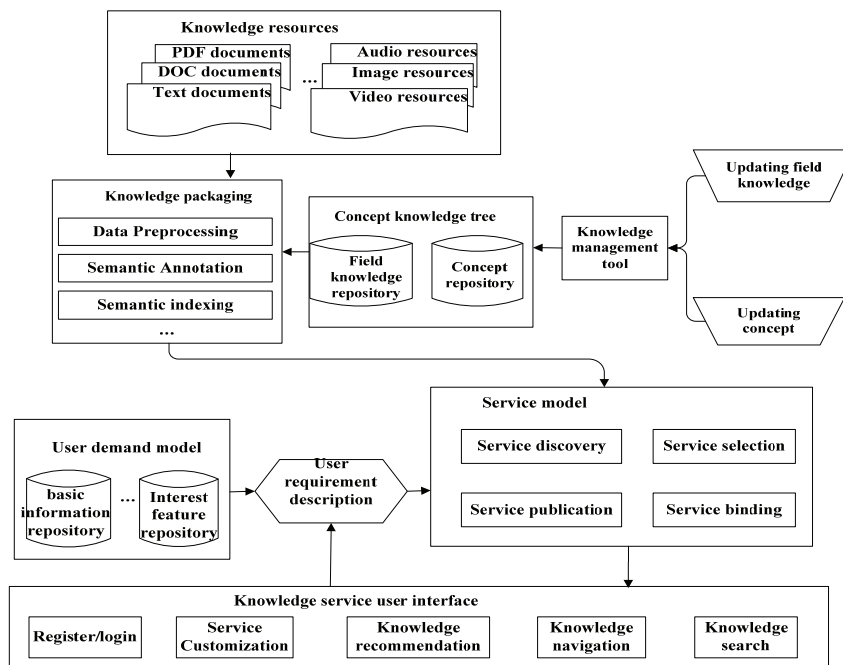


Figure 2. Knowledge service application architecture based on concept knowledge tree

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