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An Object-oriented Knowledge Link Model for General Knowledge Management

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ABSTRACT

The knowledge link is the basic on knowledge share and the indispensable part in knowledge standardization management. In this paper, a object-oriented knowledge link model is proposed for general knowledge management by using object-oriented representation based on knowledge levels system. In the model, knowledge link is divided into general knowledge link and integrated knowledge with corresponding link properties and methods. What's more, its BNF syntax is described and designed.

Keywords: Knowledge; Knowledge management; Knowledge representation; Knowledge link model

1. INTRODUCTION

The value of knowledge management is mainly focus on how to find the knowledge needed by organization, and to share it to support the decision and bring benefit [1]. Knowledge management as a planned, structured approach to manage the creation, sharing, harvesting and leveraging of knowledge as an organizational asset, to enhance a company's ability, speed and effectiveness in delivering products or services for the benefit of clients, in line with its business strategy[2]. Knowledge management is the science that is to integrate and reconstruct the process of creating, acquiring, organizing and utilizing information (Bair, 1999). With the development of IT, knowledge management doesn't rest on the range of organization and ultimately will break through the boundary of organization [3-5]. Because of different standards of knowledge management in the organization, intercommunion among organizations is difficult to some degree. So, it's necessary to establish universal standards for knowledge collecting, storing and sharing and implement structured knowledge management. Standardization will make businesses repeat active results brought by successful knowledge management behaviors, and to identify and reconstruct knowledge activity (Dominic Kelleher, 2002).

In the course of actual decision, the decision maker of organization needs to use all sorts of knowledge [6]. But in the actual operation, knowledge management needs to store the knowledge in knowledge base to manage it. Knowledge has many kinds with different characteristic and representation. It's the important problem in knowledge management that how to bring these kinds of knowledge into the same system framework to realize the acquirement, storage and utilization of knowledge.

But from recent study articles on knowledge management, it is found few study has concern about the problem of knowledge standardization management. In order to realize the standardization management of knowledge, the standardization of knowledge link is one of key parts, which is the basis of knowledge share. The article aims to define and construct an object-oriented knowledge link model for general knowledge management. In the model, object techniques is used to represent the knowledge based on knowledge levels system, and according to knowledge body, the knowledge link is made up of the general knowledge link and integrated knowledge. The corresponding BNF syntax on links is described and designed after given each properties and methods.

2. KNOWLEDGE AND KNOWLEDGE REPRESENTATION

2. 1. Knowledge Levels System

Relationship of data, information and knowledge should be known and understand in order to comprehend how to share and manage knowledge. Data are the visual originality cells, they could be turned into information when them be stored orderly. Until a rule used with them, they then transformed into knowledge. But, to some extent, knowledge is a kind of ability, it will make information be work in practical decision [1-9].

Generally, there is much knowledge in knowledge management. According to actual need of decision problem solving, Knowledge can be divided into three levels (fig.1): foundation knowledge, specialty knowledge and integration knowledge. Foundation knowledge is the general and elementary knowledge of professional field, it's the basal information to know professional field. Specialty knowledge is all sorts of applied and researchful knowledge on all professional field. Integration knowledge is the knowledge integrated for certain task, which includes basic knowledge and specialty knowledge corresponding with the task. In these levels, there are visible and invisible knowledge. Visible knowledge can be filed and stored in the computer, but invisible knowledge is hard to obtain because it stored in brains as the experience from study and practice.

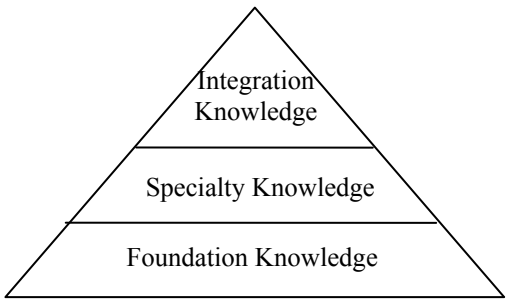

Fig.1 Knowledge levels system

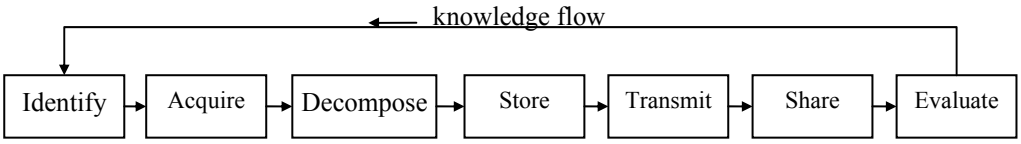

Fig. 2 The process of knowledge flow in enterprise

In actual enterprise, these knowledge are integrated into business knowledge flow to work in term of some processes. The process of knowledge flow is disparted into seven steps: identify, obtain, decompose, store, transmit, share and evaluate (fig. 2). Usually, knowledge management and its system are elaborated on the basis of the process of knowledge flow.

2.2 Knowledge Representation

Knowledge representation is key part of knowledge management, which describes the general formalism for ordering, recording and acquiring of any fragment of knowledge [7]. Acquired knowledge must be represented into some form or it isn't been recorded. In the course of knowledge management, there is no knowledge representation, no knowledge application. Knowledge representation is not only vital to knowledge process (efficiency, scope, etc), but also direct influential to knowledge acquirement and learn mechanism. So far, many methods of knowledge representation have been put forward by experts, such as logic representation, relation representation, rule representation and object-oriented representation, and so on. By comparing them, object-oriented representation gains the advantage of module, inheritance and encapsulation, etc. The knowledge represented by using object is close to real world and its project is more comprehensible and accepted.

Object knowledge representation that use object techniques, gives a possibility to unify in one abstract "object" the compound structures of data with procedures, in which the procedures work on the hermetic structure of this object, or they allow for communicating some objects with the other objects. The advantages of object technique are inheritance, polymorphism and virtuality. The presented advantages of object programming decided that this method has been chosen for knowledge representation in an decision support system or knowledge management system. This aids the designing of the technological processes of body machining and knowledge management [7].

To improve knowledge management, one needs to work out the methods of the representation on body and knowledge. Body representation conduces to understand and improve the process of knowledge management and knowledge representation help to realize the standardization of knowledge management. Based on knowledge levels system, the object technique is applied to represent foundation knowledge, specialty knowledge and integration knowledge. There are two stages commonly:

- **Object identification:** To determine and identified object classes which can affect application domains as well as the inner structure of objects: properties and object's methods. Due to lack of general methods of object and object classes identification, the participation of skilled experts is required in this process.

- **Design of object class structure**: To define the connections and relationships between particular objects. Definitions of the hierarchical structures of classes consist of distinguishing the base class called "ancestor" and derivative classes called "descendants".

3. KNOWLEDGE LINK MODEL

Based on knowledge levels system and knowledge representation, the knowledge link model is created and designed (Fig.3). Because foundation knowledge and specialty knowledge have much similarity on properties and methods, they are combined into the same link part named after general knowledge link. So, in the model, there are two types of knowledge link which are general knowledge link and integrated knowledge link, which can be denoted as follows:

$$KL = \_ (KL_g , KL_i)$$

Where KL is knowledge link, KL_g is general knowledge link and KL_i is integrated knowledge link.

General knowledge includes foundation knowledge in common use and specialty knowledge, and integrated knowledge includes problem-solving knowledge, experience knowledge or instance. In the object technique, they are two knowledge classes that have respective subclasses (Fig. 4).

For problem solving, the general knowledge link mainly offer frame and body of general knowledge access for user to acquire and choose material general knowledge, and the integrated knowledge link mainly offer frame and body of integrated knowledge access for user to acquire correlative experience knowledge or instance corresponding to certain task.

3.1 General Knowledge Link

Considering storage and structure of knowledge (knowledge body properties and methods), general knowledge link can be divided into such five parts as system link, input link, fact link, output link and operation link. Of them, system, input, fact and output belong to knowledge body properties, and operation is knowledge body method. Then, there is:

$$KL_g = (SL_{system}, IL_{input}, FL_{fact}, OUL_{output}, OPL_{operation})$$

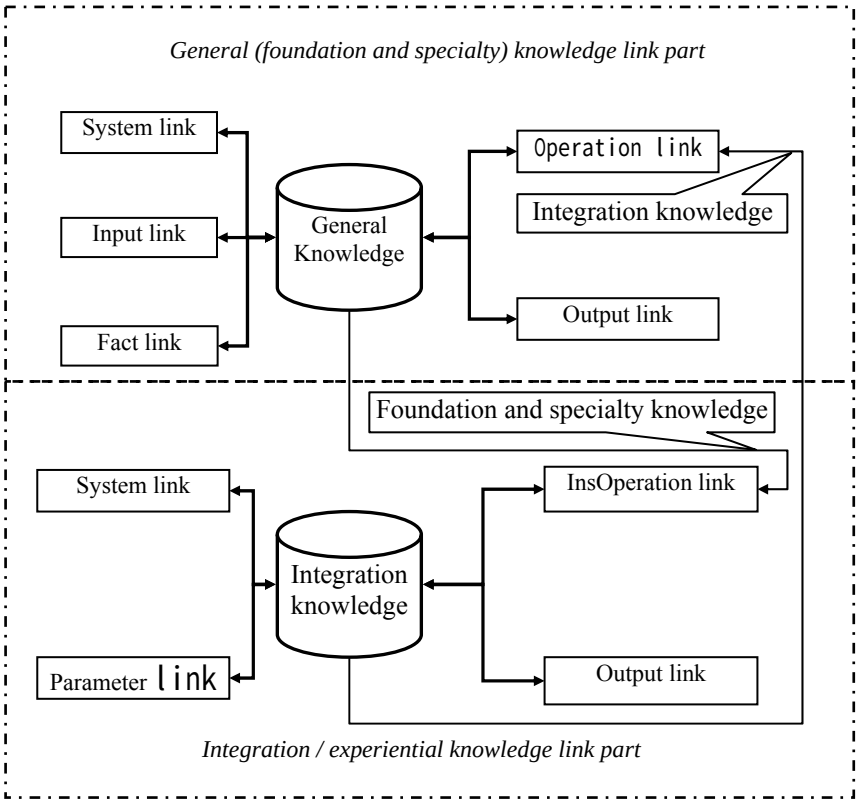

Fig.3 Knowledge link model

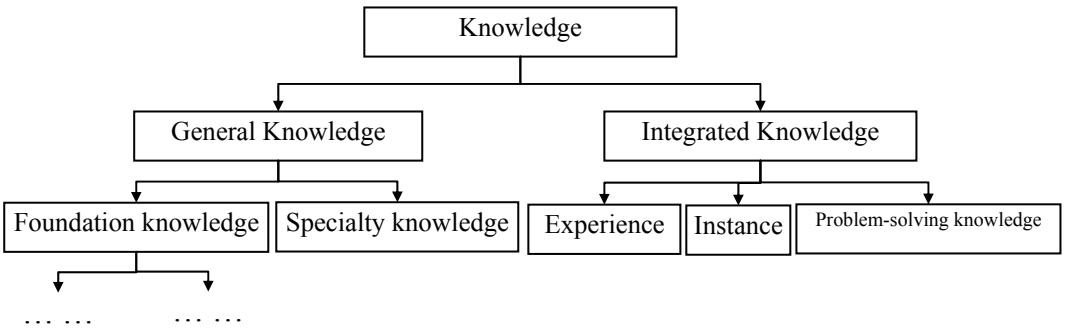

Fig.4 Knowledge object class definition

Where KL_g is general knowledge link, SL_{system} is system link, IL_{input} is input link, FL_{fact} is fact link, OUL_{output} is output link and $OPL_{operation}$ is operation link.

And the BNF expression is:
KL_g:: = "G-Knowledge" object as {"System", "InPut", "Fact" , "OutPut", "Operation" }

(1) **System Link**
System link is the port that is used for user to connect with material system and server. In the link, there are parameters that are "server" and "userparms". Of them, the parameter "sever" is made up of two variables: IP address and Server Name, and the parameter "userparms" is made up of two variables:User ID and password. So, there is as follow:

System:: = ["Sever", "UserParms"]
Sever:: = ["IPAdress", "ServerName"]
UserParms:: = ["UserID", "PassWord"]

(2) **Input Link**
Input link is the port that is used for user to realize the input function of knowledge body. Here, under the support of object-oriented techniques, knowledge is input as the same form to be stored in the database. The parameters in input link mainly include "objects", "attributes" and "expression". The parameter "attributes" is made up of variables "AttriName", "AttriDescription" and "AttriType". There is as follow:

InPut::=["Objects", "Attributes", "Expression"]
Objects:: = ["ObjectName"]

Attributes:: = [“AttriName”, “AttriDescription”, “AttriType”]
AttriName:: = < string >
AttriType:: = < public | private | shared |…>
Expression:: = < string >
ObjectName:: = < string >

(3) **Fact Link**

Fact link is the port that is used for user to acquire fact knowledge on foundation knowledge and specialty knowledge. Here, “fact knowledge” is a perceive knowledge on knowledge at present and it maybe is an understanding, experience or idea which is different from distinct user. In the link, the parameters include “FactID”, “FactObject” and “FactDescription”. Of them, the parameter “FactObject” is made up of InstanceObjects whose properties are time, object name, used resource and outputted result and its operations, corresponding to variables “Time”, “Object”, “Resource”, “OutPut” and “InsOperation”. The variable “Object” maybe experience or instance which can connect with integrated knowledge link. There is as follow:

Fact:: = [“FactID”,” FactObject”, “FactDescription”]
FactObject:: = [“InstanceObjects”]
InstanceObjects:: = “Instance” object as
{“Time”, “Object”, “Resource”, “OutPut”, “InsOperation”}
Time:: = < datetime >
Object:: = < string | I-knowledge object >
Resourse:: = [“System ”,” Input”, “parameters”]
FactDescription:: = < string >

(4) **Output Link**

Output link is the port that is used for user to lay out knowledge or result under some rules. The parameters of the link include object attributes, applied rules and results, expressed as “Attributes”, “Rules” and “Results”. Of them, the parameter “Attributes” is made up of variables “AttriName” and “AttriType” corresponding to the input link, and the parameter “Attributes” is made up of variables “RuleID” and “RuleDescription”. There is as follow:

OutPut:: = [“Attributes”, “Rules”, “Results”]
Attributes:: = [“AttriName”, “AttriType”]
AttriName:: = < string > *//corresponding to the input link*
AttriType:: = < public | private | shared |…>
Rules:: = [“RuleID”, “RuleDescription”]
RuleID:: = < Number >
RuleDescription::= IF [“Condition”]
THEN [“conclusion”]
ELSE [“conclusion”]: [Reliability]
Results:: = < Integer | Numeric | String | Date | Boolean |… >

(5) **Operation Link**

Operation link is the port that is used for user to process and transform knowledge by using some methods. After concluding and analyzing the methods of knowledge management, the methods mainly include three types of operation, which are general operation、knowledge reasoning and knowledge mining, denoted as “GenOperation”, “ReasonRun”, “MineRun”. General operation have such functions as “write”, “delete”, “read” and ”update”, denoted as ”Kadd”, “Kdelete”, “Kread” and “Kupdate”. Knowledge reasoning is chiefly represented by using rules to manage knowledge and to control process, so its function has two parts of rule operation and reasoning control. Rule operation have such functions as “Add”, “Delete” and “Read”, denoted as ” RuleAdd”, “RuleDelete” and “RuleRead”. Reasoning control has the functions as “Execute”, “Pause” and “Stop”. The functions of knowledge mining are to choose data object, algorithm and to execute and acquire results, and their parameters are in turn denoted as “DataObject”, “Algorithm” and “Result”. In the course of knowledge process, the operation link can connect with integrated knowledge link and using interrelated integrated knowledge (experience) help to improve knowledge process. There is as follow:

Operation::=[“GenOperation”, “ReasonRun”, “MineRun”]
GenOperation::=[“Kadd”, “Kdelete”, “Kread”, “Kupdate”]
ReasonRun::= [“RuleOperation ”, “Control”]
RuleOperation::=[“RuleAdd”, “RuleDelete”, “RuleRead”]
RuleAdd::=Add[“RuleID”, “RuleDescription”]
RuleID::=< Number >
RuleDescription::= IF [“Condition”]
THEN [“conclusion”]
ELSE [“conclusion”]: [Reliability]
RuleDelete::= Delete[“RuleID”]
RuleRead::= Read[“RuleID”]
Control:: = < Execute, Pause, Stop >
MineRun:: = [“DataObject”, “Algorithm” and “Result”]

3.2 Integrated Knowledge Link

Known from foregoing part, integrated knowledge is the knowledge integrated for certain task, which maybe project knowledge, experience and instance. The knowledge is sometime systemic, comprehensive toward certain decision problem. Similarly, integrated knowledge link can be divided into such four parts as system link, task link, output link and operation link. Of them, system link is the same as one of general knowledge with uniform standard. Integrated knowledge itself doesn’t care the representation and acquirement of resources such as data, model and knowledge, but care the logic relation among system resources and the realization of corresponding operation. So, the relation structure of knowledge is emphasized in the link. Then, there is:

$KL_i = \ .\ (SL_{system}, TL_{input}, OUL_{output}, OPL_{operation})$

Where KL_I is integrated knowledge link, SL_{system} is system link, TL_{input} is task link, OUL_{output} is output link and $OPL_{operation}$ is operation link.

And the BNF expression is:

KL_i:: = “I-knowledge” object as
{“System”, “Task ”, “Resourse”, “OutPut”, “Operation” }

(1) Task Link

Task link is the port that is used for user to acquire and set actual task which is core of integrated knowledge. The parameters of task have “TaskObject” and “Attribute”. The parameter “TaskObject” is made up of such variables as “TaskName”, “Type” and “Description”. The parameter

"Attribute" is made up of such variables as "AttriName", "AttriDescription", "AttriType" and "DataType". There is as follow:

Task :: = ["TaskObject", "Attribute"]
TaskObject:: = ["TaskName" , "Description"]
Attribute :: = ["AttriName", "AttriDescription", "AttriType", "DataType"]
AttriType:: = < public | private | shared |…>
DataType:: = < Integer | Numeric | String | Date | … >

(2) Output Link

Output link is the port that is used for user to lay out knowledge or result after several steps of operation. In the link, the parameters mainly include knowledge object "KnowledgeObject", process "Process" and result "Result". Of them, the parameter "KnowledgeObject" is made up of variables "ObjectName", "KnowledgeType" and "Description", and the parameter "Process" is made up of variables "Resources" and "Methods", and the parameter "Result" is made up of variables "Attributes" and "SolveResult". The value of variable "KnowledgeType" is "project" or "experience" or "instance", and the objects of variable "Resources" include data, model and knowledge. There is as follow:

OutPut:: = ["KnowledgeObject", "Process" , "Result"]
KnowledgeObject:: = ["ObjectName", "KnowledgeType" , "Description"]
ObjectName:: = < String >
KnowledgeType:: = < project | experience | instance >
Description:: = < String >
Process:: = ["Resources", "Methods"]
Resources::= ["DataObject", "ModelObject", "KnowledgeObject"]
DataObject :: = "Data" object as {"DataObject", "DataRestriction", "ModelOperation"}
ModelObject:: = "Model" object as {"ModelObject", "Parameter", "ModelOperation", "OutPut"}
KnowledgeObject:: = "G-Knowledge" object as {"System", "InPut", "Fact", "KOperation", "OutPut"}
Methods:: = ["TaskObject" , "TaskSolving"]
TaskObject:: = ["TaskID" , "TaskName" , "Description"]
TaskSolving:: = ["TaskID" , "MethodObject"]
TaskObject:: = ["MethodName" , "Expression" , "Description"]
Result:: = ["Attributes", "SolveResult"]
Attributes:: = ["AttriName", "AttriType"]
SolveResult:: = < Integer | Numeric | String | Date |… >

(3) Operation Link

For integrated knowledge, the operation includes initializing, process control and result management, denoted as "Initialize", "Control" and "ResultM" in turn. Of them, the parameter "Initialize" is made up of variables "SolveType", "Data", "Model" and "Knowledge". The results including solving process and outcome can be save as fact to the database of general knowledge, connecting with the fact link in the general knowledge link. There is as follow:

InsOperation::=["Initialize", "Control", "ResultM"]
Initalize::=["SolveType" , "Data", "Model", "Knowledge"]
SolveType::= < ModelSolve | DataSolve >
Data::= ["DataObject"] // DataObject is the same as output link
Model::= ["ModelObject"] // ModelObject is the same as output link
Knowledge::= ["KnowledgeObject"] // KnowledgeObject is the same as the general knowledge link
Control::= < Execute, Pause, Stop >
ResultM::=["Query" , "Add", "Delete", "Save", "Saveas"]
Saveas::= Save as ["Fact"] // Fact is the same as fact link in the general knowledge link

4. CONCLUSION

Along with the progress trend on system intelligence, knowledge management has been vital more and more to decision support system (DSS). As an important problem of knowledge management standardization, knowledge link has a direct effect on the realization of knowledge management. The aim of this paper is to present the concept of the knowledge link and to construct a general knowledge link model. Based on knowledge levels system, knowledge representation is elaborated in the form of a set of objects, and then the model of knowledge link and its BNF syntax are brought forward. The main advantage of the proposed model of knowledge link is that it can offer a uniform and normative method and link interface to share and use system knowledge with shielding the difference about concrete knowledge. In the whole system, the model displays with uniform behavior and property and makes knowledge integrated effectively.

It is almost impossible to solve all problems via a single study. In spite of our study that has presented a solution of knowledge link model based on object-oriented techniques, many problems still need to be solved, such as corresponding knowledge storage structure, knowledge management mechanism on automatically choosing the best. Further work will be focus on improvement of the proposed knowledge link model in order to increase integration of data, model and knowledge, and establishment of knowledge management mechanism which includes choosing the best, containing and correcting error automatically. The application of the knowledge link model in actual decision environment will be also the aim of the future work.

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