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A Social Knowledge Network-Based Intelligent Framework for Finding Right Persons in OKCs

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Abstract. With the rapid expanding of learning content resources and users, it is difficult for learners to find right persons they need as knowledge experts and learning peers in open knowledge communities (OKCs) using traditional search engines. According to this situation, the paper presents a social knowledge network-based intelligent framework for finding right persons in OKCs. The architectural details of the framework are proposed in this paper. The authors expound the idea of the intelligent framework design, the work principle and mechanism of each module.

Keywords. right persons finding, SKN, ontology, linked data, SWRL, LDA, SNA, Learning Cell Knowledge Community

1. Introduction

Open knowledge communities (OKCs) are online and open learning environments which provide good opportunities for taking part in knowledge authoring and sharing collaboratively and exchanging knowledge, experience and resources among users [1]. Better person-to-person interaction, discussion and collaboration in OKCs may not only solve learning problem immediately to improve learning performance [2, 3, 4, 5], but also eliminate the study of loneliness effectively to improve learning satisfaction and motivation [6, 7]. However, with the rapid expanding of learning content resources and users in OKCs, it is difficult for learners to find right persons they need as knowledge experts and learning peers using traditional search engines.

Proving right persons finding service for learners to search right knowledge experts and learning peers efficiently is vital for smart learning, because right persons may offer authoritative, trustworthy knowledge and collective intelligence for learning. Based on the idea, the paper presents an intelligent framework for finding right persons

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in OKCs employing hybrid technologies. The architectural details of the framework are designed in this paper. Authors also expound the idea of the intelligent framework design, the work principle and mechanism of each module.

The rest of this paper is organized as follows. In Section 2 are presented related works. Section 3 presents our statement of the problem. Section 4 describes an intelligent framework for finding right persons employing hybrid technologies. Finally, Section 5 presents our conclusions and future work.

2. Related Works

The experts finding is also called expert search or expert location that is aimed at discovering the relevant experts with higher authority knowledge. TREC set up experts finding task in 2005. There are many studies on experts finding to find persons with higher expertise, experiences, or skills in organizations and open online communities.

The earliest experts finding systems for organizations focused on expertise identification based on description information of experts' skills stored in a structure database [8, 9]. With the rapid expanding of information in the internet, experts finding for open online communities have been attracted more studies [10].

Many approaches and algorithms are proposed to finding experts. The language model is used to calculate probability between query topics and candidate experts [11, 12, 13]. Topic-sensitive probabilistic model is proposed to find expert in question answer communities[14].Through the construction of the users' social network, methods based on social link network analysis have achieved experts finding in open communities (such as Yahoo! Answers or Java forums) and enterprise organization [15]. Ontology can provide formal and sharable representation of knowledge. Based ontologies experts finding method is also proposed to improve the search results [16, 17, 18, 19]. At the same time, there are many hybrid methods proposed to find expert using language model, topic model and social network linked analysis [20, 21, 22].

Previous studies provide approaches for the right persons finding in OKCs. However, these studies mainly focus on finding persons from the view of knowledge while ignore different learning needs and persons' roles in OKCs.

3. Problem Statement

In the OKCs environment, users and knowledge are linked through various social learning interactions among users and knowledge. In the process of social learning interactions, a user in OKCs has different roles such as expert, peer, learner, and so on. For example, when a user has created a lot of knowledge relevant to Java Programming, it seems most likely that the user is an expert in the field of Java Programming. As learners, they have different learning needs in different context. Sometimes, learners hope to find the authoritative knowledge experts relevant to specific topics to solve problems in learning process. Sometimes, learners hope to find peers who have the same interest for discussion and communication. Therefore, as for learners, experts and peers are the right persons for learning. So, based on the above two contexts, we defined our research problem that is how to find the right experts and peers for each learner efficiently and effectively in OKCs. Figure 1 depicts research question.

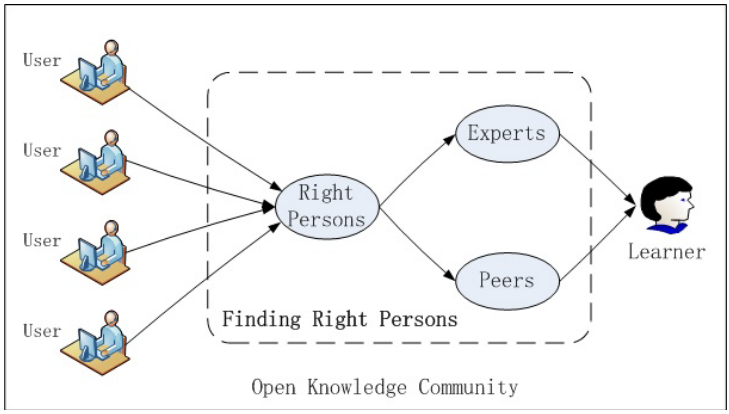

Figure 1. Research statement of finding right persons

4. RPFinder : An Intelligent Finding Framework

The intelligent right persons finding framework called RPFinder includes seven components logically: SKN Construction, RPs Generator, Query Semantic Parser, Semantic Matching, Semantic Reasoner, RPs Ranker and RPs Finding GUI. The architecture of RPFinder is illustrated in Figure 2.

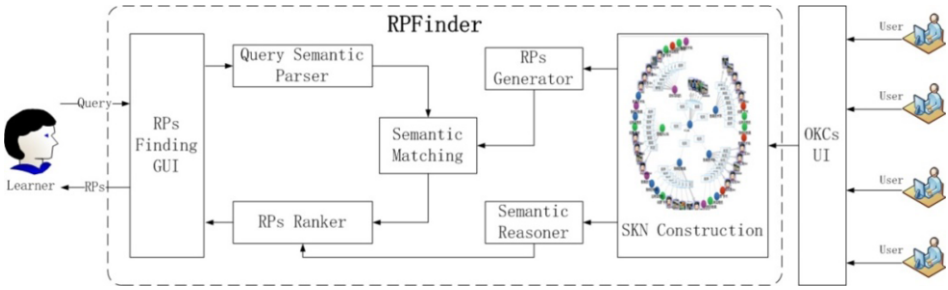

Figure 2. RPFinder intelligent finding framework

4.1. SKN Construction

In OKCs, people and knowledge are connected with each other through various social learning interactions in different learning contexts. Due to various learning interactions between people and knowledge, OKC forms a social knowledge network (SKN). SKN is a composite representation of graph model of a social network and knowledge network, specifically with RDF semantic graphical representation. The aim of SKN Construction is to build a semantic linked data network. We define the social knowledge network as follows:

Definition (Social Knowledge Network). SKN = <N, R, L> where

- N = <PN, KN> represents the collection of nodes, where PN represents a collection of person nodes, KN represents a collection of knowledge nodes;
- R = < P2P, P2K, K2K > represents the collection of relations, where the P2P is a collection of relations among persons, P2K represents a collection of relation

between persons and knowledge, K2K represents a collection of the relationship between knowledge and knowledge;

- L:R → N represents correlation function, the associated relationships with person and knowledge nodes.

Ontology is a semantic organization technology for explicit and formal description about concepts, properties and relationships providing high level meaning. Ontologies are important for the SKN Construction. We use two ways to build the ontologies. One way is to construct an ontology called SKNO for explicitly and formally describing person, knowledge and their social interactive relations in OKCs from the learning perspective. A part of class hierarchy of the SKNO is illustrated in Figure 3. SKNO consists of three type classes: *Knowledge, Person and PKR*. *Knowledge* is an abstract concept including different learning resources such as a learning object, a learning tool, a learning cell and so on. *Person* is a concept to represent actor involved in learning process which consists of three sub-concepts: *Learner*, *Peer* and *Expert*. *PKR* is composed of three type classes *P2P*, *P2K* and *K2K* representing different relationships between *Person* and *Knowledge*.

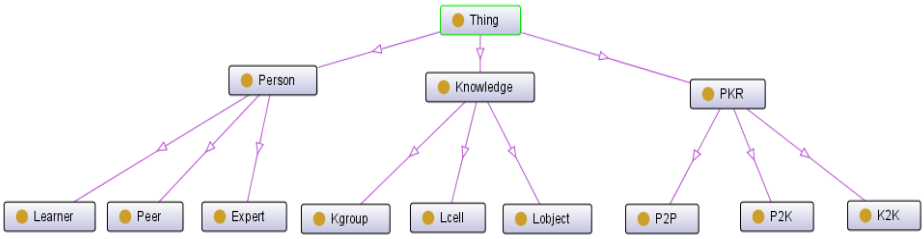

Figure 3. A Protégé screenshot representing a part of class hierarchy of the SKNO

Another way is to utilize and extend the existed ontologies such as LOM for describing the learning content, DC for general web resources description, SKOS for relevant concepts and taxonomy description, FOAF for people description, and so on.

Linked data facilitates web-scale data interlinking and realization of semantic knowledge network based on a set of well-established principles and W3C standard technologies, e.g. RDF, SPARQL, HTTP URIs [23].

SKN Construction is aimed at generating social knowledge network employing the above ontologies and linked data technologies to link person and knowledge from the OKCs log. SKN is a RDF graph for storing semantic and linked learning data. Figure 4 depicts an example of SKN.

4.2. RPs Generator

The represent of Right Persons (RPs) is the core function of the RPs Generator. In OKCs, person as an entity has many characteristics in the view of learning offer. From the perspective of knowledge, RPs should have the higher degree of correlation in the specific domain knowledge. From the perspective of knowledge quality, RPs should have the higher degree of knowledge authority. Meanwhile, the availability and reputation of the RPs are the important factors for learners.

Taking into consideration of the above characteristics of the RPs, we define five parameters to represent RPs including knowledge-related degree (KRD), knowledge-

authority degree (KAD), social reputation degree (SRD), community availability degree (CAD) and community usability degree (CUD). According to five parameters model of RPs representation, five two-dimensional matrixes (KRD matrix, KAD matrix, SRD matrix, CAD matrix and CUD matrix) are created to represent RPs and relationships between RPs and knowledge.

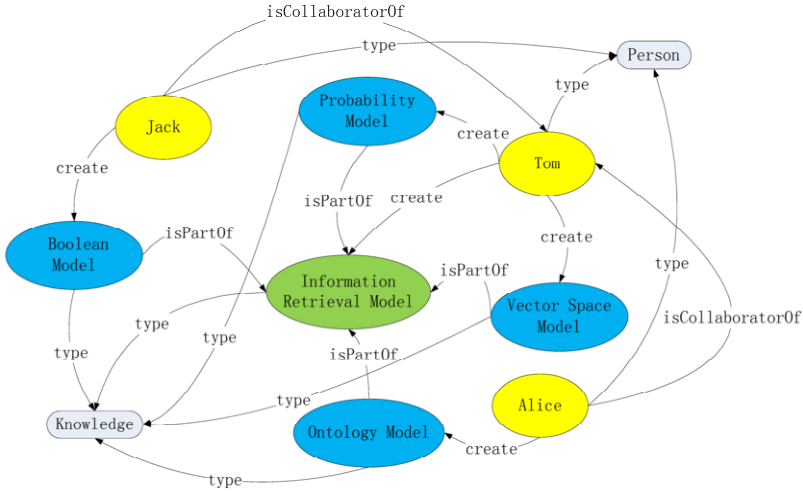

Figure 4. An example of SKN

RPs Generator can generate the five two-dimensional matrixes employing hybrid technologies base on SKN. For the matrix of KRD, we use expert finding approach base on topic mode (LDA) [14] to compute the relevance between RPs and knowledge. For the matrix of SRD, we use social network analysis techniques (SNA) to compute the social reputation of RPs. For the matrix of KAD, semantic link analysis techniques are utilized to compute knowledge-authority of RPs. For the CAD matrix and CUD matrix, we use SPARQL to get data from SKN.

4.3. Query Semantic Parser

Semantic Parsing is the process of converting query into a formal and logical meaning representation to understand learners' real learning needs. Query Semantic Parser is designed to get semantic information from the learners' request employing the general ontologies and domain ontologies that is aimed at enriching search query information.

4.4. Semantic Matching

Semantic Matching is aimed at computing semantic relevance between the output of Query Semantic Parser and the characteristics of RPs generated by RPs Generator. The LDA mode is utilized in the process of the semantic similarity measures of Semantic Matching.

4.5. Semantic Reasoner

Semantic Web Rule Language (SWRL) is an expressive rule language that enables users to write rules that can be expressed in terms of OWL concepts to provide powerful logical reasoning capabilities [24]. Semantic Reasoner is designed to finding new relationships in SKN. A SWRL rule defining is as follows: isCollaboratorOf(?x, ?y) ^ isCollaboratorOf(?z, ?y)-> Peer(?x, ?z). In this rule, isCollaboratorOf(?x, ?y) represents that ?x is collaborator of ?y and Peer(?x, ?z) represents that ?x is peer of ?z. If the relationship between isCollaboratorOf(?x, ?y) and isCollaboratorOf(?z, ?y) is satisfied ,then Semantic Reasoner can get new relationship Peer(?x, ?z) . Using the above rule, Semantic Reasoner can get latent semantic relationship in SKN and find new relations among persons to get more social network information in SKN.

4.6. RPs Ranker

After the process of Semantic Matching and Semantic Reasoner, the RPs Ranker gets the calculation result to rank the RPs according to the five parameters model of RPs representation, so as to evaluate the RPs from five perspectives..

4.7. RPs Finding GUI

RPs Finding GUI is a graphic user interface for accepting learners' query and providing multi-visual right persons finding results. RPs Finding GUI provides two types of finding service: Peers Finding and Experts Finding. Learner can choose the finding service. As for learners' query, it provides friendly search textbox to enable learner input query request in the format of keywords or natural languages. It also offer quick search templates and advanced search functions for learners to satisfy learners' different needs. After inputting, RPs Finding GUI provides finding knowledge relevant persons with different views: list view and network view.

5. Conclusions

Finding right persons is vital for smart learning. If we find right persons, we can get the channels to gain knowledge and communication opportunities. This paper introduces the design of an intelligent framework for finding right persons in OKCs. Considering the social interaction characteristic of OKCs, a novel SKN model is proposed to represent the integration space of social network and knowledge network utilizing the ontologies and linked data technologies. Based on the SKN construction, functions and mechanism of the modules of RPs Generator, Query Semantic Parser, Semantic Matching, Semantic Reasoner, RPs Ranker and RPs Finding GUI are designed and expounded.

For the future, we will develop and realize the intelligent right persons finding system (IRPFS) in our Learning Cell Knowledge Community (http://lcell.bnu.edu.cn/) which is an online and open knowledge community to provide intelligent finding service for learners. The IRPFS will be implemented based on many open-source ontology editors and development tools such as Protégé, Jena, SWRLTab, Jena TDB

and so on. We will test and evaluate the RPFinder in different learning context using qualitative and quantitative methods

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