Learning path creation to achieve learner's goal for Web Based Training using RDF

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Abstract

In this paper, we present a system which creates learning path to achieve learner's goal for Web Based Training (WBT). In our system, each learner can set his goal in two styles: by specifying a teaching material and by specifying a person. In first style, our system creates learning path to understand specified material. On the other hand, our system also shows how to be a specified person. For learning path creation, our system uses metadata of teaching material and user profile. Metadata of teaching material describes its prerequisite knowledge and knowledge which it teaches. User profile describes learner's knowledge and his goal. Those metadata and profile are expressed using Resource Description Framework (RDF).

1 Introduction

E-learning, especially Web Based Training (WBT), has become very popular. Many companies provide a lot of teaching materials for it. Universities also put teaching materials on Web, so we can find a lot of teaching materials and learn with them.

We have one big problem in such learning situation: there are too many teaching materials for us to learn with the materials to achieve our learning goal. As an example, we will consider the situation that a beginner programmer wants to master server-side Java programming technique. If he knows some keywords which can represent his goal, like "servlet", "JSP", "Java Beans" and so on, he can use full text matching with them and find some materials which teach what he want to know. But he can not understand it because he lacks basic knowledge, like basic Java grammar, basic idea of concurrent programming, working model of servlet working model, and so on. It is much harder to find materials which teach such prerequisite knowledge of his goal. It is also difficult to make effective learning order of materials: it is not effective for his learning if he starts learning servlet working model before he finish the material which teaches basic idea of concurrent programming.

We solve this problem by creating learning path from learner's knowledge and his goal. In our previous paper [4], we presented learning path creation system depending on learner's knowledge and his preference. We improve this system and introduce new algorithm for creation learning path to achieve learner's goal.

In this paper, we present learning path creation system. We employ RDF to describe knowledge of teaching materials and learners. With our system, each learner can find the most effective learning path to his learning goal.

This paper is structured as follows: In section 1, we take an overview of our system. we describe how to describe knowledge of teaching materials and learners, how to set learning goal, and learning path creation algorithm. Section 3 describes current system implementaion. Finally, section 4 concludes this paper and describe our future works.

2 Overview

In order to express knowledge, we use a set of *concepts*. Each concept is represented by a keyword. We allow relations such as *is-a* and *part-of* among concepts, so the concepts have a graph structure. Learner profile and metadata of teaching materials are described with this structured set of keywords.

Learner profile describes learner's knowledge. It is a set of concepts and degree of understanding of each concept. Degree of understanding is calculated by the score of placement test.

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Each material has two metadatas: a set of prerequisite concepts and a set of concepts which learners can learn from it. It is also properly ordered so that learners can learn a concept before they need it as a prerequisite. For example, metadata is describes like that "This material teaches how to write servlet, jsp pages, and Java Beans. You have to learn basic Java grammar, basic idea of concurrent programming, and basic working model of servlet container, before you learn with this material."

Figure 1 shows the overview of our system. Agent, which is set in the middle of the figure, creates learning path. If a learner set his goal to the agent, it creates learning path from learner profile and metadata of teaching materials like that "Your goal is to learn with this document, so your have to understand Java grammar, concurrent programming, and working model of servlet container. Starting with learning basic Java grammar, next is basic idea of concurrent programming. When you finish both of them, you can understand working model of servlet container. It is your learning path."

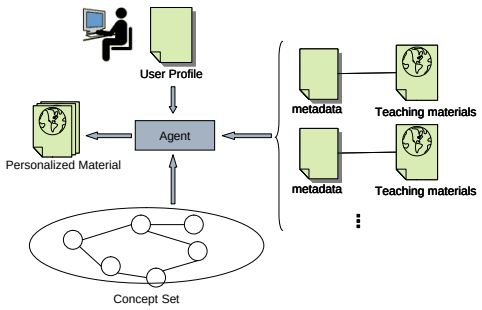

Figure 1: System Overview

2.1 Goal selection

In our system, each learner can set his goal in 2 style: specifying a teaching material which he wants to learn finally, and specifying a person who is in our system ,whom he wants to be. When he want to know the learning path to understand certain teaching material, he specify his goal in first style. With second style, a learner can get learning path to be a specified person. A learner can get same knowledge of specified person by learning with created learning path. For example, if a learner specify a master of server side Java programming as his goal, our system creates learning path to be server side Java programming master and learning with it, he will be a server side Java programming master too.

2.2 Learning path creation algorithm

Our system provides two style to specify a lerner's goal, but both style use almost same learnig path creation alogorism. Learning path is created by following 5 stages.

1. creates unknown concept set
2. selects most effective teaching material and add it to learning path
3. updates learner's knwon concept set virtualy
4. updates unknow concept set
5. repleats 2, 3 until unknown concept becomes empty

Our system creates learning path to reduce unknown concept. At first stage, it initializes unknown concept set If goal is given as a teaching material, initialization proceeds with following formula.

$$U_n = (P_g \cap \bar{K_n})$$

P_g is prerequisite concepts of teaching material g, which is set as a goal. Unknown concept set U_n is calculated as a union of P_g and concepts which a learner has never known($\bar{K_n}$).

If goal is given as a person, unknown concept set is calculated as a union of $\bar{K_n}$ and concepts which goal person has already known (K_g). It is formulated as following one.

$$U_n = (K_g \cap \bar{K_n})$$

After initialization, our system enters learning material selection stage. In this stage, our system select the most effective learning material to reduce items in unknown concept set. The most effective learning material is defined as following formula:

$$max(Tj \cap U_n)$$

After selecting the most effective teaching material, our system calculates learning effects of selected material(M_n), and updates learner's knowledge virtually. Currently, all concept has binary value:

known or unknown, thus leaner's knwoledge is replesented as known concept set. Update is done as take union of known concept process set of a learner who has never learned selected material yet, and concept set which selected material teaches (T_{M_n}).

$$K_{n-1} = (K_n \cup T_{M_n})$$

Unknown concept set is also updated, using virtually updated known concept set and prerequisite concept of selected teaching material.

$$U_{n-1} = ((U_n \cup P_{M_n}) \cap \bar{K_{n-1}})$$

Stage $2 \sim 4$ is repeated until unknown concept set becomes empty. In case unknown concept set never become empty, learning path creation is terminated when it repeats specified times. After all stage is finished, our system tells learning path to a learner. Learning path is defined as following formula.

$$\Sigma_{k=1}^{n} M_k$$

3 System implementation

We implement our system as a Web application. Figure 2 shows the implementation overview. It gathers metadata from servers which have teaching materials and stores them in its RDF database. When a learner accesses the system, Web interface sends a query to the RDF database, generates the result according to selected algorithm and shows the result as a Web page. By clicking hyperlinks in the result, learner can access the real teaching materials. Figure 3 shows an example of the generated result. Since we use RDF, we can combine the result with other systems.

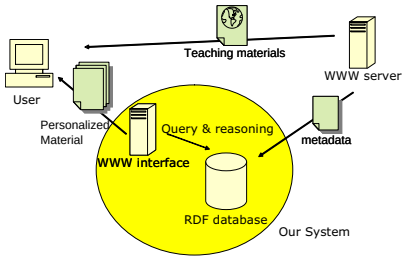

Figure 2: Implementation Overview

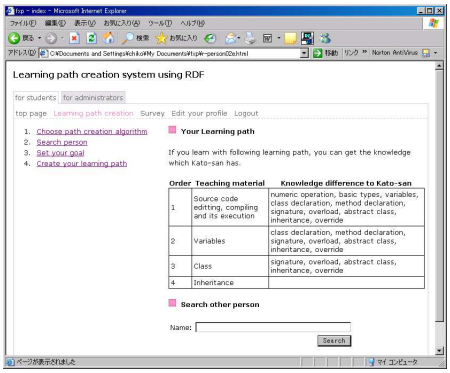

Figure 3: An Example Result

3.1 RDF representation

We use RDF to express charactoristics of teaching material and its learner because of RDF's openess. The properties which we use in our system is defined as figure 4 showing. The prefix of `fxp` is a name space for properties. `fxp:pre` and `fxp:teaches` are used to represent the relationship between a teaching material and concepts. `fxp:knows` is a property for relationship between a learner and concepts.

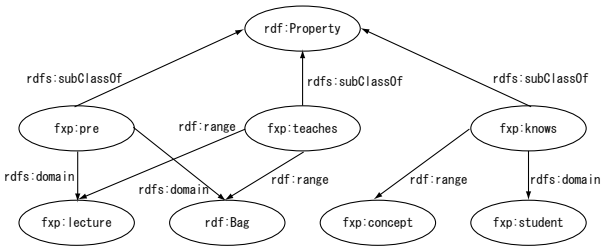

Figure 4: RDF schema

Each teaching material has some concepts as prerequisite. There are $1 : n$ relationship between teaching material and its prerequisite concepts, To manage concepts, we use `fxpc` as a name space for concepts. The teaching material has `fxp:pre` property, which is a shortage of prerequisite,and its value is a set of concept. We use anonymous `rdf:Bag` typed resource to express a set of concept.

We also use similar structure to express what concepts the teaching material teaches. When we ex-

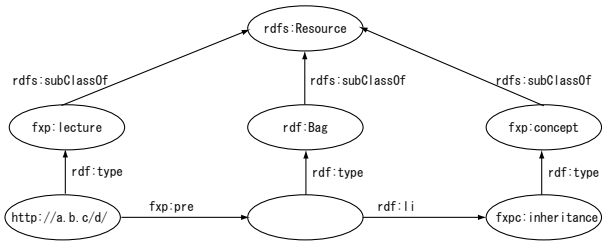

Figure 5: Prerequisite of the teaching material

press this relationship, `fxp:pre` property is replaced by `fxp:teaches`.

Every learner is distingushed by URI which belongs to `fxpc` namespace. The learner has many properties but we use only `fxp:knows` for learning path creation, of which value is a set of concepts the learner has already known. Figure 6 shows how to use this property.

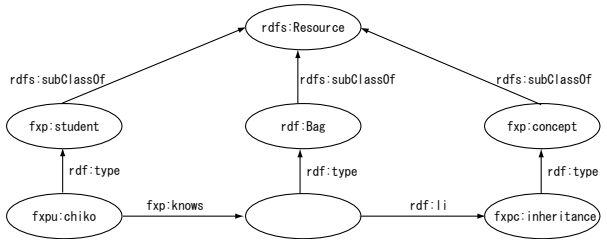

Figure 6: Learner's knowledge

4 Conclusion

We have a lot of teaching materials on Web. When we learn with them, there is one big problem: it is hard for us to create most suitable learning path by our self. We don't know what teaching material should we learn and how to order them to achieve our learning goal effectively. Our system help us by creating learning path to learn specified material and to be a specified person. We think our system makes it easy for each learner to achieve his learning goal.

4.1 Future works

We have implemented the system and tried several examples in order to test that our system works properly. We will conduct actual experiments and evaluation. Followings are some of our future works:

- Estimate learner's knowledge (profile) without doing placement tests
- Combine our system with other systems which use RDF
- Employ standalized ontologies

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