Chapter 33
Intelligent Learning System Based on Ontology for Network Learning

Xie Yong

Abstract In this paper, we used ontology and semantic annotation to construct the intelligent network learning behavior analysis system, based on network learning behavior model and concept relations in the network learning domain to build the ontology base, extract metadata, or semantic annotate data of the behavior information which we collected. Match the semantic parsed data with ontology base to deduce learners' learning effect, to evaluate learning process, and to give some advice for learners' learning. This system can help development of network learning platforms and educational resources also help teachers in designing and organizing the curriculum.

Keywords Ontology · Network learning · Intelligent learning system

33.1 Introduction

With the Internet and network technology developing, network learning became the primary instructional media in our life [1, 2]. Learners can study with network learning at any time. It provides personalized, virtualized cooperative studying environment for learners' learning [3, 4]. Learners' behavior reflect multistructural and multilevel properties in the network environment, so analyzing learners' behaviors are essential to develop the network learning platforms and educational resources, to help teachers designing and organizing the curriculum, to provide guide for learners' studying [5].

X. Yong (✉)
Modern Education Technology Center, Xi'an Institute of Foreign Affairs,
Xi'an 710077, China
e-mail: xieyong3434@163.com

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Unfortunately, many analysis systems only carry out surface and manual, not in-depth, automatic analysis. In this paper, we will introduce ontology and semantic annotation into the network learning behavior analysis system, which is able to automatically analyze and make the analysis result more intelligent and reasonable. Outlines the basic idea of the system framework, describes the process of creating analysis system for network learning behavior, and explains the data flowing in the framework. Afterward we show an example, analysis of a learner' behavior who is learning through the network learning.

33.2 Related Works

33.2.1 Network Learning Behavior and its Model

It includes behavior subject, behavior object, behavior tools, behavior community, community organizations rules, and division of labor, and so on. Network learning behavior showed multidimensional and multilevel property compared with traditional learning behavior.

Commonly, the network learning behavior divides into three levels: low-level, mid-level, and high-level [1]. In general, it includes browsing page, information search, sending and receiving e-mail, real-time exchanging, BBS discussion, asking questions, answering questions, downloading, browsing lesson plans preservation, and so on. Table 33.1 is the detail description of network learning behavior model. We build ontology base and evaluate the network learning behavior based on the network learning behavior model.

33.2.2 Ontology

An ontology is defined as "a common vocabulary for researchers who need to share information in a domain. It includes machine-interpretable definitions of basic concepts in the domain and relations among them." The domain is the subject area and ontologism is, basically, systems of categories.

Ontology specifies a rich description of the:

- Terminology (vertices in a graph);
- Concepts (vertices in a graph);
- Relationships between the concepts (directed edges in a graph);
- Rules;
- A set of instances assigned to a particular concepts (data records assigned to concepts or relation).

Table 33.1 Use metadata description part of concepts in online learning behavior model

Network learning behavior	Properties
Browsing page	URL, title, keyword, time(into pages, exit pages),low-level network learning behavior
Browsing lesson plans	The theme of lesson plans, time (enter page, exit page, frequency), the lesson plans (read, unread),low-level network learning behavior
Information researching	Keywords, searching results, searching engine, low-level network learning behavior
Downloading	Sources, keywords, URL, description, low-level network learning behavior, form
Sending and receiving e-mail	Address, the theme, mid-level network learning behavior
BBS discussion	Subject; the number of reading time, frequency, posting number, whether was deleted, the number of articles, high-level network learning behavior
Asking questions	Theme, frequency, the number of back, mid-level network learning behavior
Answering questions	Theme, frequency, the number of correct, the number of wrong, high-level network learning behavior
Real-time exchanging	Tools, exchanging time, theme, content, high-level network learning behavior

In short, ontology is relevant to a particular domain or area of interest.

In this system, the ontology is used as the following:

Describing the content of learning subjects, learning objects,learning behaviors, learning effect, learning tools, learning evaluation, and their relations;

Using the semantic annotation to mark learners' learning contents and learning behaviors, learning tools;

Imposing a structure on the information in the domain;

Retrieving information based on the ontology which we built;

Resolving semantic heterogeneity problem through ontology rules;

According to semantic annotation data, querying the ontology base, based on this to deduce learners' learning affects, and to give the learning evaluations;

Generally, we use metadata to describe concepts and their properties in ontology, Table 33.1 [1] is part of the concepts in the network learning behavior model description with metadata.

33.3 System Architecture

33.3.1 System Functional Blocks Diagram

Figure 33.1 is the system functional block diagram of intelligent network learning behavior analysis system. Different colors of the arrows in the model represent

different block, the following illustrates each function of the block. The core of this model is the semantic parsing and the ontology base, as shown in the red.

33.3.1.1 User Interface: The Layer Include Following Part

User interface: learners can learn or operate in this web base interface. It provides a convenient operation user graphic interface.

Web Service API: provide supporting for other programs of distance learning system or famous across platform application service.

33.3.1.2 Data's Collecting Layer

The block of data collecting is used to collect the data of network learning behaviors. It has two ways to collect data. First is the asynchronous collecting, learners input the information before the first learning. Second is the synchronous collecting, the layer through real-time tracking to record the network learning behavior information.

33.3.1.3 Intelligent Semantic Parsing: This Method Focus on this Part

Data parsing: using grammar parse the data, find out the subject, predicate, and object of the sentence, make them meet the triple of subject–predicate–object, where the concepts are classified by ontology and enable the computer to

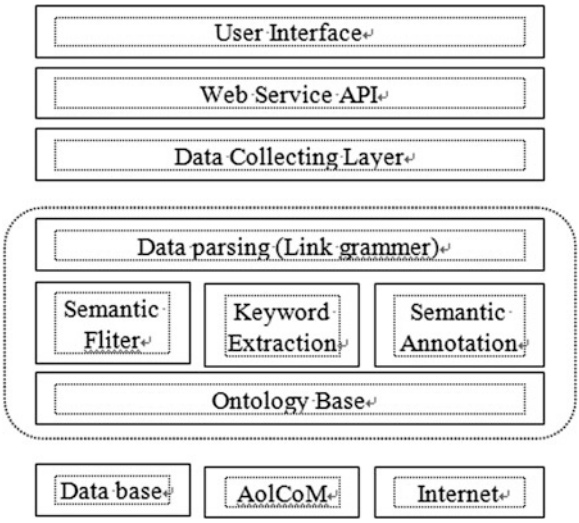

Fig. 33.1 System functional blocks diagram

understand or distinguish the relations between words and sentence in grammar structure.

Semantic filter: this engine cooperates with syntax analyzer to precede keyword extraction. It applies to wrong grammar check [2].

Metadata extraction: metadata extraction is to extract critical words based on Table 33.1; it focuses on extracting metadata which can reveal the word indexing of theme of the resource.

Semantic annotation: the metadata is extracted, but it is lack of machine reasoning ability. After metadata extraction, we need to semantic annotation of data, and then use the data pattern matching with the data in the ontology base.

33.3.1.4 Store Data Layer: The Layer Includes

Ontology base: ontology base is important in the system. In our research we use Protégé_3.4 (http://protege.stanford.edu) as an ontology-developing environment.

Concrete steps are as following:

First, according to the definition of the metadata and their attributes in Table 33.1 construct the classes, properties, and examples.

Second, build relation among the concepts. Developing the class hierarchy and defining relation of concepts are important.

Typically, we create a few definitions of the concepts in the hierarchy and then continue by describing properties of these concepts and so on. The two tasks are always twisted and should be done at the same time

Data base: data base used to store the collecting the data of network learning behavioral and final analysis result which are basis for the next analysis.

AOlCoM: the ALOCoM ontology is a generic content model that defines a framework for Los (Learning objects) and their components [3]. It is the network learning standard material developed by XML.

Internet resource: the source of knowledge extraction includes various Internet data, which is useful to analyze the learning behavior. First, according to the definition of the metadata and their attributes in Table 33.1 construct the classes, properties, and examples.

33.3.2 Datas Flow in the Somatic Layer

Figure 33.2 is the data flowing in the Semantic layer. The process as following:

The block of data collecting collects the data of learners' behavior;

Syntax analyzes the collected data through the data parsing, and mark them meet the triple of subject–predicate–object;

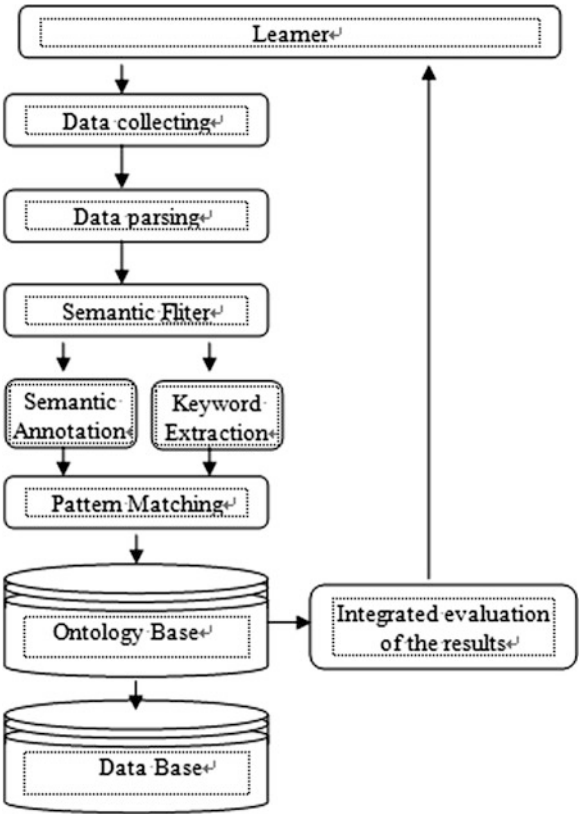

Fig. 33.2 Data flowing in the SEMANTIC layer

Semantic filter check the analysis result;

Extract metadata's from the syntax analysis result and semantic annotate the analysis data;

Use the semantic annotation data or the metadata to match with the ontology base, to evaluate learners' behavior, to infer learning motivation, learning strategy, and the behind learning effect;

Integrate the analysis results and display it for learners and store the evaluation result and data of learners' behavior in database for the next analysis' input.

33.4 An Application Example

In this section we depict a simple application on intelligent network learning behavior analysis system in order to illustrate the proposed model.

One learner (Lily) for the first time study in the network learning and she inputs some information about her learning custom, educational background, learning

object, and so on. And then she learned aIl through browsing page, asked three questions and answered one question, exchanged information with other students. Data collecting layer collect some information based on Table 33.1, extract the metadata or semantic annotate the data, construct the ontology structural drawing, matched it with the original data in the ontology base, to deduce learner's learning effect, to given a evaluation for Lily's learning and some advice of learning more effectively, and store the analysis result in database, As a basis for the next analysis.

33.5 Conclusions

Network learning behavior can be defined as learning based on the environment which is created by modern information technology and include new communication mechanism with rich resources, to carry out web-based or distance autonomous learning behavior. But, the system cannot be logical deduction; ontology base is built manually rather than automatic extending. Of course, some behavior evaluation is not very accurate. Future research we will focus on these issues.

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