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Computer Science Engineering in the Field of Philosophical Concept

Rashmita Panigrahi, Ashok Muduli, Satyabrata Das, Rasmi Sarangi
Department of Computer science and Engineering, NM Institute of Engineering and Technology,Bhubaneswar , Odisha
Department of Computer science and Engineering, Raajdhani Engineering College,Bhubaneswar,Odisha
Department of Computer science and Engineering ,Aryan Institute of Engineering and Technology Bhubnaeswar , Odisha
Department of Computer science and Engineering,Capital Engineering College

ABSTRACT—*A computer knowledge system plays a crucial role in computer education owing to the diversification and speedy development of computer courses. There are many curriculum resources, especially in China, but most of them are relatively independent and cannot guide students to acquire more knowledge which is relevant to this course directly. To relieve these issues, in this paper, we propose an ontology system for the computer course architecture (OSCCA) to instruct, guide, and direct students efficient learning. OSCCA collects undergraduate course catalogs from the twenty famous Chinese universities and some network education websites. Then course entities and their interrelationships are culled to build Chinese course ontology. Based on these roles, OSCCA can provide effectively and contributed learning guidance to the fresh learner and OSCCA is developed by Java.*
Keywords—*computer education, Computer course architecture, ontology viewing, computer ontology system*

I. INTRODUCTION

With the development of computer science and technology, numerous computer courses and curriculums have been spread on the internet. Most of them are relatively independent, which leads to problems that a fresh learner cannot obtain reasonable curriculums and courses easily immediately without other assistance.

To solve the problem, some previous systems have been developed. In 2015, Chayan Nuntawong, et al. presented a process model and a system for calculating the correspondence between the content of courses in Computer Science with the standard of The Thailand Qualifications Framework to improve the curriculum of universities in Thailand by meeting the standards and decreasing the duration of the operation to be more convenient [1]. In 2016, Karim Hadjar, et al. employed a case study to illustrate how the ontology assists web search engine to help user find useful information from huge amount of unstructured information [2]. In 2016, Antonio Maffei, et al., used of CONALI ontology as tool to represent the courses in an engineering program and evaluate the alignment of their activities [3]. In 2017, based on ontology system, A. Barbagallo, et al. developed a E-Learning for the Semantic ECM which allows the creation of e-learning courses which are customized according to the needs and learning preferences of the user [4]. In 2018, Hui Ma, et al. proposed a new approach for ontology-supported web-based HR recruitment systems which is facilitated by Formal Concept Analysis (FCA) for constructing domain-specific ontologies to model position requirements and applicants' competences [5]. In 2019, Mohammad Aman Ullah, et al. presented and summarized different ways of reasoning the ontology and tried to fill the gap between existing works by including all the concepts and their related data and object properties [6].

In this paper, a computer course architectural ontology system (OSCCA) is built to associate computer fresh learners to select and explore a set of appropriate and reasonable course and curriculums. OSCCA employs some machine learning algorithms to extract and construct the relationship among the computer terms. These computer terms are utilized by Jena [7] to automatically establish the inner relationship of ontology. The OSCCA is develop by Java and provides web server for user.

II. THE OVERALL DESIGN

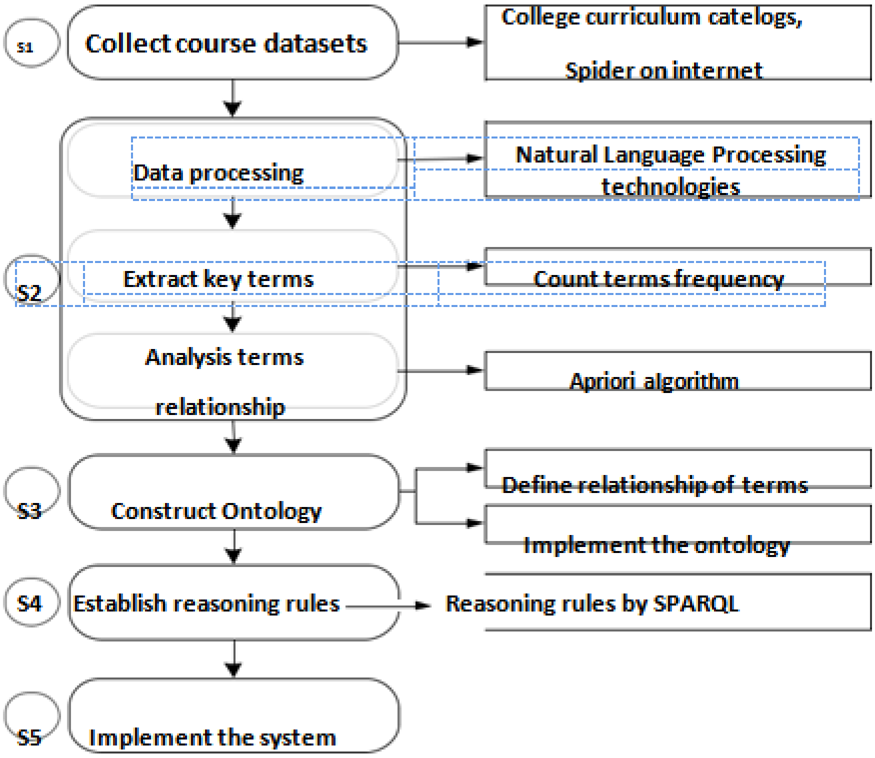

Fig. 1. The overall design of the ontology system of Computer course architecture. There are five steps to construct the ontology system of Computer course architecture, Step1(S1): collect course datasets, Step2(S2): analyse and define the relationship among course, catalogs and knowledge points Step3(S3): construct ontology system, Step4(S4): establish reasoning rules, Step5(S5): Implement the system by Java

Figure 1 shows the overall design of OSCCA. Five basic steps are needed, including data collection, data pre-processing, constructing Ontology, establishing reasonable rules and implementing the system. Firstly, some course, units and knowledge points corpus are collected from the raw data which includes curriculums arrangement of some famous universities, internet course, and some computer forum. The second step is crucial step, at first, all of the raw data is processed by natural language processing (NLP) [8]. And then, based on some NLP methods such as word segmentation, entity Recognition and semantic analysis et al., a series of key and master terms would be found. After getting these useful information, we use Apriori algorithm [9] to extract and analyze the interrelationship of items. Thirdly, the interrelationships of these items are applied to construct an ontology by Jena which employs Protege OWL API to automatedly construct based courses ontology system for computer science. To enable the OSCCA has inference ability, we define four reasoning rules which can direct inference processing. Finally, we build a website by Java which can provide available services for other fresh learner in computer science.

III. COLLECT COURSE DATASETS

Course datasets are collected from some college curriculums and internet information. College curriculums source from some university official websites and the internet course information are fetched by Scrapy (a Python spider package) [10]. The Course datasets consist of courses, units and knowledge points. The relationship among the three categories data is shown in Figure 2. According Figure 2 Courses include Units and Units include knowledge points. knowledge points are smallest meta items. User can find a set of curriculums and course by the meta information.

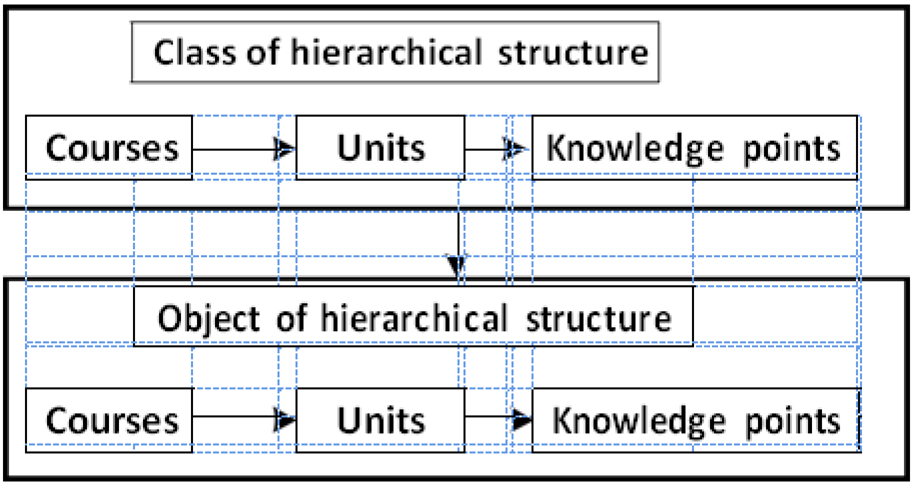

Fig. 2. The hierarchical structure of Courses, Units and Knowledge points.

IV. THE ANALYSIS OF TERMS RELATIONSHIP

To analyze the relationship of terms, the relationship of each item should be defined. In this paper, we employ NLP to detect and extract useful and contributed items. In data processing, words segmentation technology (a kind of NLP technology) is used. A continuous sentence will be segmented, filtered, and counted to get key terms. The selected key items are analyzed by the Apriori algorithm. Apriori algorithm aims to solve frequent items set problems and can assist rule learning on transactional databases. Apriori algorithm can be described as follow:

Apriori(T, ϵ)
  $L_1 \leftarrow \{\text{large } 1 - \text{itemsets}\}$
  $k \leftarrow 2$
  while $L_{k-1} \neq \emptyset$
    $C_k \leftarrow \{c = a \cup \{b\} \mid a \in L_{k-1} \wedge b \notin a, \{s \subseteq c \mid |s| = k-1\} \subseteq L_{k-1}\}$
    for transactions $t \in T$
      $D_t \leftarrow \{c \in C_k \mid c \subseteq t\}$
      for candidates $c \in D_t$
        $count[c] \leftarrow count[c] + 1$
    $L_k \leftarrow \{c \in C_k \mid count[c] \geq \epsilon\}$
    $k \leftarrow k + 1$
  return $\bigcup_k L_k$

Based on the rules and relationship of key items, we can construct courses ontology system by three steps: defining the relationship of items, constructing courses ontology system by ProtégéOWL API [11] and building the reasoning rules system. There are four relationships which include leading, trailing, inclusion and ownership relationship.

There are certain learning orders in the chapters of course. Taking a certain subject knowledge for example, we can find the precursor knowledge infers to the concept of subject knowledge when we cannot understand some concepts clearly. The precursor knowledge of a certain knowledge point is relatively clear and easy to obtain. Because the precursor relationship is transitive, which can transfer to the next concepts. Herein, we take the three chapters of A, B and C for example. If you want to learn C course, you need to learn B content. As the same time, if you want to learn B content, you must master A content firstly. If A course or unit lead to B content, and the interrelationship is transitive, we can reckon that A course is the process of B content. Based on the interrelationship, when the learning of the course chapters reaches a certain knowledge point, its following learning knowledge points may not be unique, so the best candidate needs to be selected under the condition when the following concepts is a uncertain choices. The more relevant following concepts content of the concept is determined according to the correlation obtained from the previous analysis and statistics. Similarly, to making the internal system more closely linked. we take the contents of three chapters of A, B and C for example. After mastering the content of a knowledge, we can learn the content of Chapter B or the content of Chapter C. That is to say, there is a following relationship between C content and A content, which is reversible. Inclusive relationship mainly refers to the content of chapters included in the course, and the content of chapters also includes the content of knowledge points. Ownership and inclusion are reciprocal, which mainly manifests itself in the case of concepts and concepts. Relevance refer to the contents of the two chapters which belongs to the same field of knowledge but cannot be determined whether there is a clear following relationship.

Although relevance is not defined in the body, but it is the implicit relationship derived from the curriculums. There are no unambiguous definition of the interrelationship. Based on the defined interrelationship we can construct rules inference system.

After defining several conceptual relationships and conceptual instances, these relationships need to be defined in the ontology. First of all, we need to define the orientation of the chapters with the relationship between the leading and the following. According to the order in the curriculum arrangement of the twenty computer colleges, we can refer to the chronological order of the curriculum arrangement of colleges and universities. Moreover, because the selected data sources cover a wide range, there are still individual courses that cannot verify the relevance when selecting the relevant keyword pairs. Therefore, in order to make the system has better performance and expand the coverage, it is also necessary to refer to the interrelation between school content courses and improve the ontology.

After preparing all the data information to construct the course ontology, we will construct the course ontology. Because the data of the courses, chapters and knowledge points included in the computer course ontology in this paper are very large, if we construct it manually by Protégétool, it will not only take time and effort but also cannot avoid some undetectable errors, so this paper chooses to construct the course ontology. Protege OWL API is used to complete the automatic construction of ontology. Finally, the created ontology file is imported into Protege for subsequent adjustment and improvement.

V. ESTABLISH REASONING RULES

To make OSCCA can reason automatically, we defined the following five based rules.

Rule1: if a includes a1, a1 includes a2, a2 is related to b2, b2 belongs to b1 and b1 belongs to b, we can reason a is related to b.

Rule2: if a includes a1, a1 includes a2, a2 leads to b2, b2 belongs to b1, b1 belongs to b, we can reason a lead to b directly.

Rule3: if a includes a1, a1 includes a2, a2 follows up b2, b2 belongs to b1 and b1 belongs to b, we can reason a directly follows up b.

Rule4: if a leads to b and b leads to c, we can reason a can lead to c.

Rule5: if a follows up b and b follows to c, we can reason a can follow to c.

Based on above rules, we use Protégé to show the interrelationship among some course name, units names and knowledge points. Figure 3 is an example of Java course to show the five basic rules. From the relationships between items and knowledge point of Java course, we can see that some item or knowledge point is related and some item which can lead to multiple knowledge points. The relationships of each item are the basic elements for inference. The inference of courses ontology system for computer science can assist user to find their interesting knowledge points.

We show some based functions of OSCCA, including home page, course query page, course information page and recorded page.

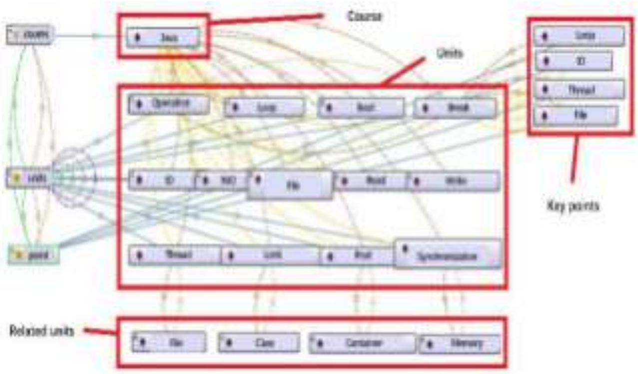

Fig. 3. An example of Java course to show five basic rules

VI. SHOWED BASIC FUNCTIONS OF OSCCA

Figure 4 shows the home page of OSCCA, users could type a course or a key word of the course, then OSCCA could show the query results. These query results are calculated by inference rules and algorithms automatically.

Fig. 4. The home page of OSCCA

When user wants to some detail information of some knowledge points, user can click detail information link. Figure 5 shows course information. If the user selects a course, OSCCA can show all knowledge points and the order to guide the user study.

Fig. 5. The course information page of OSCCA

Figure 6 is relative courses page. When user types an interesting course name, units name or a knowledge point, OSCCA can find and give some relevant contents which are listed orderly by degree of correlation.

Fig. 6. The relevant courses page of OSCCA

Fig. 7. The recording page of query of OSCCA

OSCCA can record the query information which can assist the user know what has been queried. Figure 7 shows the record page.

VII. CONCLUSION

With the number of computer course rapidly increasing, most computer science courses are quite independent. A fresh learner of computer science may be confused by numerous guidelines from internet and experiential suggestion. To solved this problem, a course ontology system for computer science education is developed.

In this paper, we develop an ontology system for computer course architecture (OSCCA) based on data mining technology OSCCA can assist students to choose a useful and beneficial learning curriculum. By extracting the relationship between chapters and knowledge points of computer courses, we propose ontology construction method by analyzing the computer course system and the ontology hierarchy, extracting the course entities, and defining the inference rules between courses. Based on fifty computer courses, we use data mining method and protégé software to automatically construct the computer course system ontology. Finally, we implement the OSCCA on web servers and shows some basic functions. In a word, OSCCA is a useful and knowledgeable courses ontology system for computer science education.

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