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PREFACE

Welcome to XIIIth International Scientific and Technical Conference **Computer Sciences and Information Technologies** CSIT 2018, which is organized by IEEE Ukraine Section, IEEE West Ukraine AP/ED/MTT/CPMT/SSC Societies Joint Chapter, Lviv Polytechnic National University, Institute of Computer Science and Information Technologies, supported by Technical University of Lodz Poland, Institute of Information Technologies, patronized by Ministry of Education and Science of Ukraine.

The international conference **Computer Sciences and Information Technologies**, established in 2004, is annually organized with the principal aim to discuss modern trends in computer sciences, information technologies, applied linguistics, and others related areas. To achieve this goal, various aspects of computer science will be presented in such major topics:

- Artificial Intelligence;
- Computational Intelligence;
- Computer vision;
- Information modeling of database and knowledge systems;
- Intelligence control systems and technologies;
- Computational linguistics;
- Project Management;
- Cyber-physical systems;
- Software Engineering;
- Intelligent management technologies.

CSIT 2018 Program Committee evaluated over 260 submitted papers to crystallize a high-level technical program of oral presentations. To continue previous successful practice, CSIT 2018 hosts three international scientific workshops: *International Workshop on Inductive Modelling IWIM-2018, International Workshop on Project Management IWPM 2018,* and *International Workshop on Information modeling, Data and knowledge engineering IWIMDKE 2018,* all supported by IEEE.

The sincerest, boundless gratitude of organizers is sent to members of International Program Committee, who supported CSIT 2018 conference by participating in it, their comprehensive reviews allowed the conference to participate in the promotion of science and technological excellence. It should be proudly mentioned, that some papers are common for several institutions, and even countries, involved in the conference. Such examples of international cooperation, that we have noticed in papers, submitted this year, has inspired CSIT 2018 International Program Committee and Organizing Committee to encourage the cooperation – even in preparing this book of Conference proceedings. As you may see, the cover of this book is decorated with a watercolor of Lviv Polytechnic National University main building. This work belongs to Victoria Halimurka – the graduate student of Department of Design and Architecture

Fundamentals, Institute of Architecture of Lviv Polytechnic National University. This watercolor painting, among other students' works, was prepared at this year's Scientific Festival, organized by Lviv Polytechnic National University. We thank Victoria and wish all the best in her future achievements, and hope that such cooperation will set a new tradition in Computer Sciences and Information Technologies conference organization.

Conference CSIT 2018 and satellite Workshops will be held in Lviv which is the largest city in Western Ukraine and the seventh largest city in the country overall. The historical heart of Lviv city is famous for its old buildings. The city center is on the UNESCO World Heritage List. Lviv is one of the most important cultural centers of Ukraine, famous for art, literature, music and theatre. It hosts more than 100 festivals annually, has 60 museums and 10 theatres. With regard to its urban fabric and architecture, Lviv is an outstanding example of the fusion of the architectural and artistic traditions of Central and Eastern Europe with those of Italy and Germany. The CSIT 2018 conference will be held in early autumn, and Lviv will be at its best: the city is famous for its welcoming and hospitality, its beautiful parks, diverse cuisine, fascinating history and charismatic architecture. Please, be sure of our warmest gratitude for you interest and participation in the conference.

We are looking forward to welcoming you in Lviv and at CSIT 2018!

Sincerely yours,

Mykola Medykovskyy
Director of Institute of Computer Sciences and Information Technologies of Lviv Polytechnic National University, Ukraine
CSIT 2018 Executive Chair

Lviv 2018

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***Abstract*—Authors proposed to construct the fuzzy ontology of the academic discipline taking into account the educational material content, its complexity characteristics' and studying time. Proposed approach is based on the individual learning path using the fuzzy logic tool. Fuzzy rules, developed in MatLab environment, are applied in Protégé ontology editor using the Fuzzy OWL plugin. That enabled to implement the fuzzy ontology constructing of individual learning path for the academic discipline in education domain.**

Keywords—individual learning path, fuzzy logic, fuzzy ontology, learning management system

I. Introduction

In the stage of students training is important to use modern methods and tools for students studying in IT education. At the same time, it should be noted that the training of the teaching material for learning management systems (LMS) and its semantic construction in the metadata storage requires the individual formation of educational material and the movement of students on it. In addition, e-learning materials created in different LMSs are often incompatible, due to their different formats. Problematic tasks include the excessive duration of testing and training of LMS [3].

Adaptive learning improves the educational process and provides an additional opportunity to take advantage of information technology implementation [21]. The adaptive LMS gives for a student the educational material constructing the individual learning path in accordance with intermediate test results. So, the learning individualization is important, when the student is provided with theoretical material, exercises for theory learning, instructional materials for exercises fulfilling according to student individual characteristics [1].

During the individual learning path constructing it is necessary the specify of main discipline's components – lectures, practical classes, labs, and other educational materials [3]. It makes a possibility to use ontology that provides efficient distributed access to learning resources by creating the unified knowledge base that unites academic disciplines and can be placed in the Internet. The last one makes it independent of interpreting a particular educational process [6]. As a result, the learning system works as the intelligent agent which makes selection from the knowledge base or changes it depending on the context and semantics of the described ontology for the specific training courses [5].

At present time, ontology is used together with fuzzy logic approach to eliminate uncertain information in various fields, for example, to search documents or to select learning objects for study [8].

During placing the LMS on educational Web-portal using MOODLE, the ontological approach has a number of advantages [3]. So, the actual research topic is the knowledge-oriented formation of the individual learning path to support adaptive learning using the elemental fuzzy logic and semantic web technologies in ontology environment.

II. Related Works

A definition of the learning path is considered in works [2-4].

Creation of e-LMS with the individual learning path, oriented on the semantic web, enables solving the problem of syntactic compatibility [13, 24]. However, such compatibility is not sufficient for organization of interaction between different LMS in the Internet. The reason is that the same information can be syntactically presented differently, and as a result, it may use different barriers between LMS. There are no LMS that may solve such problem at practice with representing the domain, namely using a taxonomy describing the ontology [12]. Paper [25] is devoted to coreference resolution in ontology population. Paper [26] considers problems of goal driven ontology learning.

Ontology of the discipline includes the following categories: general information (name, content, authors, index, and glossary of terms), description of the course, sequence of lectures, lectures, laboratory and practical work, list of references [16]. Papers [15, 18-22] are devoted to use of the ontologies and semantic Web in e-learning. One of the possible solutions for uncertain data processing is to ensure the fuzzy logic inclusion into ontology [6, 7, 11]. Currently the fuzzy logic application in ontology [8-10]. Authors consider the Some researched fuzzy logic theory application in ontology [7, 8, 11].

The goal of this paper is constructing the individual learning path on the base of course ontology using fuzzy logic.

III. Proposed Ontology of Discipline

In accordance with the lecturer tasks that use the e-LMS, he/she needs a detailed list of portal documents related to each other at a semantic level that would allow using the document's semantic content of LMS documents to make proper management actions. The base of such documents scheme preparation is the ontological binding of categories and documents properties to convey the semantic content of responses to the requests of different user's groups.

To create a learning object that is oriented towards the semantic web, it is necessary to determine correctly (not excessive) the taxonomy (concepts) of educational activity, as well as the properties of concepts and the relationship between concepts. To describe the internal structure of concepts, the attributes of the template documents, defined by the normative provision of education, should be used. To bind internal ontology to each other and from the root ontology, it is possible to use the ontology mapping and Ontology Web Language (OWL) [23] with the equivalence between categories and properties. It can indicate that a given class or property in some ontology is equivalent to classes or properties of another ontology.

Web-ontology is based on classes and objects and their properties and constraints meaning that objects are the set of entities with certain properties. This essence has some relations and all of them make groups by their characteristics. Therefore, full objects description, as well as the domain are represented as a hierarchical knowledge base, that enables to perform "smart" operations, for example, as semantic search and determining reliability and integrity of data [15]. However, in [5] the learning object complexity is described shortly without analytical background.

Authors proposed to improve the approach [5] using the fuzzy logic for reasoning the Complexity of Learning Object and introducing in the learning object ontology the additional category "Type of Learning Object" (see Fig. 1).

Fig. 1 shows the interconnection of basic notations. So, the lecturer is the developer of the academic course, and the academic course is developed by the lecturer. The lecturer is the developer of the lecture, and the lecture is developed by the lecturer. The lecture contains learning objects, and the learning objects are components of lecture. The learning objects are studied by the student, and the student studies the learning objects. The student answers the questions of the test, which contains answers. The learning objects contain the theoretical material, exercises, tables, formulas, reports, and they are integral parts of the learning material.

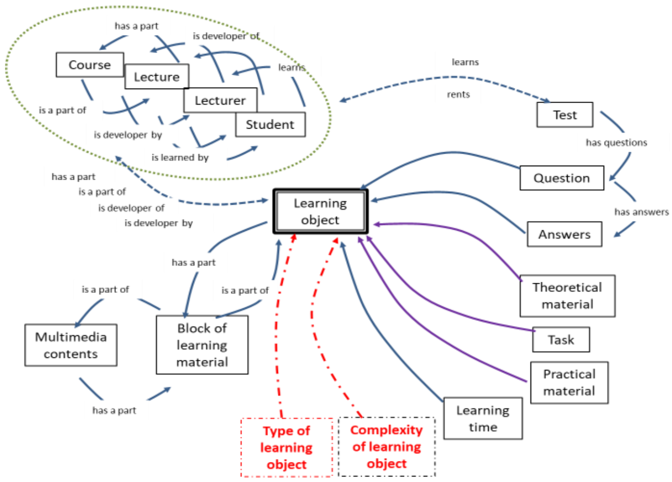

Fig. 1. Improved ontology of the learning object

We consider the complexity at adaptive learning as the integral part of an individual learning path and it can be determined using the fuzzy logic [17]. In fuzzy logic sets for mathematical model's construction it is needed to formalize linguistic information with the help of the linguistic variables notation which is words or expressions. Linguistic values are terms, and a set of all possible terms forms a term-set [17].

A trapezoidal function is used as a membership function for terms of input variables (Fig. 2), for example, learning object complexity. The feasibility of trapezoid fuzzy intervals using is conditioned by the ease of their operations performing and their visual graphic interpretation.

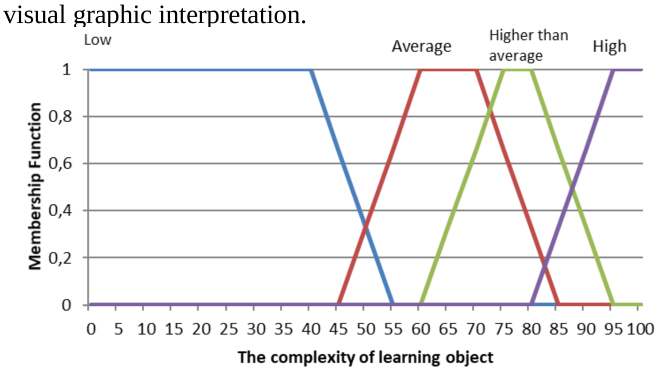

Fig. 2. The membership function for input variables terms.

In general, the membership function can be described by a function $\mu^A(u): U \to [0;1]$ that enables, for each element u of the universal set U, to calculate the degree of its membership to the fuzzy set $\tilde{A}$. The universal set U contains a complete set of values that covers the entire problem region [11].

For calculations, we use the formula corresponding to the trapezoidal membership function. As a result, a system of equations for calculating the values of the membership function per each term of the input variables is obtained:

$$\mu_{ns}(a)=\begin{cases}1; a\le 40\\ \dfrac{55-a}{40}, 40\le a\le 55\\ 0; a\ge 55\end{cases},\quad \mu_{s}(a)=\begin{cases}0; a\le 65\ or\ a\ge 95\\ \dfrac{75-a}{60}, 60\le a\le 75\\ 1; 70\le a\le 80\\ \dfrac{95-a}{80}; 80\le a\le 95\end{cases},$$

$$\mu_{vs}(a)=\begin{cases}0; a\le 45\ or\ a\ge 85\\ \dfrac{60-a}{45}, 45\le a\le 60\\ 1; 60\le a\le 70\\ \dfrac{85-a}{70}; 70\le a\le 85\end{cases},\quad \mu_{v}(a)=\begin{cases}0; a\le 80\\ \dfrac{95-a}{80}, 80\le a\le 95\\ 1; 90\le a\le 100\end{cases} \quad (1)$$

where $\mu_{ns}(a)$ – the membership function for the complexity lower than average;

$\mu_{s}(a)$ – membership function for medium complexity;

$\mu_{vs}(a)$ – membership function for the complexity higher than average;

$\mu_{v}(a)$ – a membership function for high complexity.

The fuzzy knowledge base of the fuzzy system for constructing the individual learning path has two inputs: “Level of student knowledge” and “Complexity of a learning object” and one output – “Time for study a learning object”.

The category Type of Learning Object contains the following data: basic knowledge, a theoretical material, the advanced theoretical material, the additional explaining material, practical tasks.

IV. Case Study and Implementation of Proposed Approach

For simulation of fuzzy knowledge base, we used the Fuzzy Logic Toolbox – a package of applied software that is a part of MatLab environment. On the base of this package, a system of fuzzy logical reasoning and fuzzy classification is created.

On the basis of this package, a system of fuzzy logical conclusion and fuzzy classification was created. The base of fuzzy knowledge system of individual learning path fuzzy formation has two inputs: “Level of student knowledge” and “Complexity of the learning object” and one output – “Time to learning object study.” Fuzzy system used is based on the Mamdani fuzzy conclusion tool.

The linguistic variable “Student Knowledge Level” contains the terms {Low; Lower than average; Average; Higher than average; High}. The linguistic variable “The complexity of learning object” contains the terms {Lower than average; Average; Higher than average; High}. The linguistic variable “Time to learning object study” contains the terms {Small; Average; Long}.

Operation of the proposed fuzzy system of individual learning path constructing depends on the rules base. Since each input variable is given by a different number of membership functions and taking into account the impossibility of situation where the input variable is not specified, the rule base consists of 35 “if – then” rules. Fuzzy rules are developed in MatLab environment and then they are used in Protégé ontology editor, to construct a discipline fuzzy ontology.

During fuzzy system design it is necessary to consider the values of input and output variables, as well as to develop correct rule base, which will be followed by fuzzy reasoning.

The fuzzy knowledge base developed in MatLab environment can be used in Protégé ontology editor. This Fuzzy OWL plugin is used for this one. Implementation of the fuzzy ontology for constructing of an individual learning path for the course “Decision Theory” is given below.

Fig. 3 shows individuals of the ontology of individual learning path. Here is a basic explanatory teaching material that is simultaneously explanatory, for those students who did not understand the basic element. Also, the figure depicts its complexity and the time of study. Fig. 4 shows the fuzzy ontology of an individual learning path using calculations on system of equations (1).

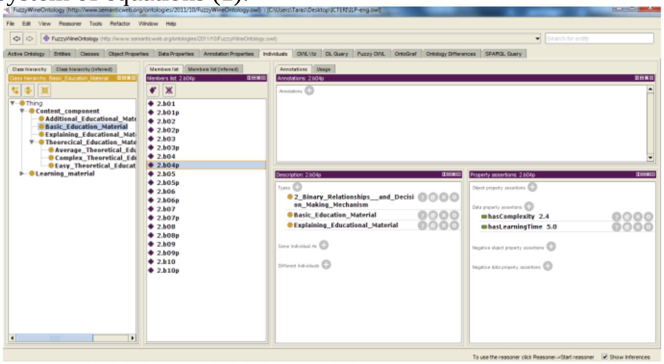

Fig. 3. Individuals of the ontology of individual learning path

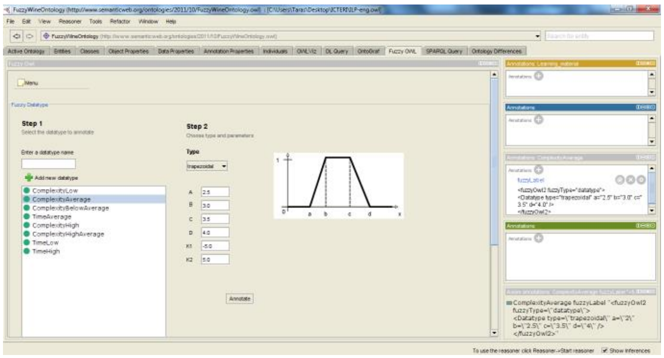

Fig. 4. Fuzzy ontology of the individual learning path

Also, it can be seen there an annotation of Learning Object Complexity. In particular, the example of defining the linguistic variable “learning objects with a level of complexity below average” is given with a following membership function:

<AnnotationAssertion>
<AnnotationProperty IRI="#fuzzyLabel"/>
<IRI>#ComplexityBelowAverage</IRI>
<Literal datatypeIRI="&rdf; PlainLiteral">< fuzzyOwl2 fuzzyType=" datatype" >
<Datatype type="trapezoidal" a=2.0; b=2.5; c=3; d=3.5; />
</fuzzyOwl2></Literal>
</AnnotationAssertion>

Experimental studies have confirmed that the time of learning material study depends on the student knowledge level and the complexity of the learning material. In particular, the implementation of an individual learning path in Protégé using the Fuzzy OWL plug-in at study of the disciplines "Decision Theory" and "Information and Knowledge Management". The sample size was 120 persons, and there were 40 test tasks.

The results of experimental studies confirmed the correctness of the scientific provisions, since the introduction of the fuzzy ontology of individual learning path construction reduces the learning time by 20% compared with the known approaches. The results proved to be commensurate, as different students and different levels of knowledge study in different groups and specialties, and test questions are simple and complex, regardless of specialty.

V. Conclusions

The fuzzy rules base, developed in MatLab environment, has applied in the Protégé ontology editor using the Fuzzy OWL plugin. This enabled implementing the fuzzy ontology for constructing the individual learning path in the academic discipline Decision Theory for the IT education domain.

An adaptive learning algorithm was developed and programmed to implement the navigation in the network of learning objects with selecting the educational fragments according to their type. It has been experimentally confirmed that the proposed approach enables to reduce the time of student studying, with the number of educational fragments of the complexity certain level and student's level in 20%.

References

[1] T. Lendyuk, S. Rippa, "Information portal of e-learning system in semantic web environment," in Proceedings of the 6th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications IDAACS'2011, Prague, Czech Republic, 2011, vol. 2, pp. 637-641.

[2] R. Hosseini, P. Brusilovsky, "A comparative study of visual cues for adaptive navigation support," in Proceedings of the 27th ACM Conference on Hypertext and Social Media, HT'16, 2016, pp. 323-325.

[3] C. De Medio, F. Gasparetti, C. Limongelli, F. Sciarrone, M. Temperini, "Course-driven teacher modeling for learning objects recommendation in the Moodle LMS," in Proceeding of the 25th Conference on User Modeling, Adaptation and Personalization, UMAP'17, 2017, pp. 141-145.

[4] P. Karampiperis, D. Sampson, "Performance evaluation of decision-based content selection approaches in adaptive educational hypermedia systems," in Intelligent and Adaptive Educational-Learning Systems, Springer Berlin Heidelberg, pp. 161-182, 2013.

[5] T. Lendyuk, A. Melnyk, S. Rippa, I. Golyash, S. Shandruk, "Individual Learning Path Building on Knowledge-based Approach," in Proceedings of the 8th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications IDAACS'2015, Warsaw, Poland, 24-26 September 2015, pp. 949-954.

[6] F. Bobillo, U. Straccia, "Aggregation operators for fuzzy ontologies," Applied Soft Computing, vol. 13, issue 9, pp. 3816–3830, 2013.

[7] À. García-Cerdaña, E. Armengol, F. Esteva, "Fuzzy description logics and t-norm based fuzzy logics," International Journal of Approximate Reasoning, vol. 51, issue 6, pp. 632-655, 2010.

[8] G. Gottlob, A. Hernich, C. Kupke, T. Lukasiewicz, "Stable model semantics for guarded existential rules and description logics," in Proceedings of the Fourteenth International Conference on Principles of Knowledge Representation and Reasoning, 2014, pp. 258-267.

[9] N. Díaz Rodríguez, M. P. Cuéllar, J. Lilius, M. Delgado Calvo-Flores, "A fuzzy ontology for semantic modelling and recognition of human behaviour," Knowledge-Based Systems, vol. 66, pp. 46-60, 2014.

[10] G. Stoilos, G. Stamou, J.Z. Pan, "Fuzzy extensions of OWL: logical properties and reduction to fuzzy description logics," International Journal of Approximate Reasoning, vol. 51, pp. 656–679, 2010.

[11] L. A. Zadeh, "Fuzzy sets as a basis for a theory of possibility," Fuzzy Sets and Systems, no. 1), pp. 3-28, 1999.

[12] T. Terano, K. Asai, M. Sugeno, Applied Fuzzy Systems, Academic Press, 2014.

[13] F. Bobillo, U. Straccia, "Fuzzy ontology representation using OWL 2," International Journal of Approximate Reasoning, vol. 52, issue 7, pp. 1073–1094, 2011.

[14] T. Tudorache, C. Nyulas, N. F. Noy, M. A. Musen, "WebProtégé: A collaborative ontology editor and knowledge acquisition tool for the web," Semantic Web, IOS Press, vol. 4, issue 1, pp. 89-99, 2013.

[15] J. Ohler, "The semantic web in education," EDUCAUSE Quarterly, vol. 31, issue 4, pp. 7-9, 2008.

[16] Standard for Learning Object Metadata. Piscataway, NJ, USA (2002). [Online], Access mode: http://ltsc.ieee.org/wg12/files/ LOM_1484_12_1_v1_Final_Draft.pdf.

[17] N. Vasylkiv, L. Dubchak, T. Lendyuk, I. Turchenko, I. Shylinska, M. Aleksander, "Tasks distribution for students testing based on fuzzy logic," in Proceedings of the 9th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications IDAACS'2017, Bucharest, Romania, 2017, pp. 26-29.

[18] S. Cakula, M. Sedleniece, "Development of a personalized e-learning model using methods of ontology," Procedia Computer Science, vol. 26, pp. 113-120, 2013.

[19] N. Manickasankari, D. Arivazhagan and G. Vennila, "Ontology based semantic web technologies in e-learning environment using Protégé," Indian Journal of Science and Technology, vol. 7, no. S6, pp. 64-67, October 2014.

[20] M. Čarapina, O. Staničić, B. Nožica, "The semantic web technologies and their integration within e-learning systems: an overview," in Proceedings of the 6th International Conference of Education, Research and Innovation ICERI'2013, 18-20 November 2013, Seville, Spain, pp. 3796-3801.

[21] P. Bouquet, A. Molinari, "Using semantic technologies in e-learning platforms: a case study," in Proceedings of the International Conference on E-Learning in the Workplace ICELW'2016, New York, June 15-17, 2016, pp. 1-6.

[22] A. Stathaki, H. Kondylakis, E. Marakakis, M. Kalogerakis, "i-Prolog: a web-based intelligent tutoring system for learning Prolog," in book Interactivity, Game Creation, Design, Learning, and Innovation, pp.337-346, 2018. DOI: 10.1007/978-3-319-76908-0_32.

[23] OWL Web Ontology Language, [Online] https://www.w3.org/TR/owl-features/.

[24] S. Maslovskyi, A. Sachenko, "Adaptive test system of student knowledge based on neural networks," Proceedings of the 8th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS'2015), Warsaw, Poland, 24-26 September 2015, pp. 940-944.

[25] N. Garanina, E. Sidorova, I. Kononenko, S. Gorlatch, "Using Multiple Semantic Measures for Coreference Resolution in Ontology Population," International Journal of Computing, vol. 16, issue 3, pp. 166-176, 2017.

[26] J. Chen, D. Dosyn, V. Lytvyn, A. Sachenko, "Smart data integration by goal driven ontology learning," in Advances in Big Data. Proceedings of the 2nd INNS Conference on Big Data, October 23-25, 2016, Thessaloniki, Greece, pp. 283-292.