1. Open-source and free: Protégé is a free and opensource ontology editor, which makes it accessible to anyone who wants to use it.
2. User-friendly interface: Protégé has a user-friendly interface that allows users to easily create, edit, and manipulate ontologies.
3. Strong community support: Protégé has a strong community of academic government, and corporate users who use it to build knowledge-based solutions in various areas such as bio-medicine, e-commerce, and organizational modeling. This support ensures that Protégé is continually updated and maintained.
4. Customizable: Protégé allows users to customize their ontologies by adding new classes and properties and modifying existing ones.
5. Integration with other tools: Protégé can be integrated with other tools such as reasoners and visualization plugins, which makes it a powerful tool for ontology development.
6. Reasoning capabilities: Protégé has built-in reasoning capabilities that allow users to check the consistency of their ontologies and detect errors.
7. Overall, Protégé is a powerful and flexible tool for creating and managing ontologies, with a userfriendly interface, strong community support, and a range of customizable features.

IV. ONTOLOGICAL MODEL

The domain ontological model was built using the Protégé editor. We have identified the following three classes: "Documents "Events "People". The "TextDocuments "Pictures "Video"and "Audio". Class "People"— subclasses "Graduates "Directors "Mentors". The "Events"class is subclasses corresponding to the reign of one or another director of the corps.

The structure of the upper level of the ontology "History of the Polotsk Cadet Corps"is shown in Figure 1.

V. CREATION OF THE INTELLIGENT INFORMATION AND REFERENCE SYSTEM

We plan to complete the creation of the Intellectual Information and Reference System "History of the Polotsk Cadet Corps"using the OSTIS technology stack. We list the advantages of this approach, which guarantee the success of the completion of the project as a whole.

1. Any OSTIS — system can be easily supplemented with new knowledge or new methods for solving problems. This allows you to quickly and easily repurpose the developed intelligent system, reorienting it to a new range of tasks to be solved.
2. OSTIS — the system is focused on the reuse of the developed components. Thanks to a single and universal SC code, a library of typical components can be created, the use of which in the design process can reduce development time by 40-60 percent.
3. OSTIS — the system is reflexive, i.e. can analyze itself, due to the fact that it is fully described using the SC code. Reflexivity is one of the most important qualities of intelligent systems.
4. Due to the fact that the design of OSTIS — the system is reduced to the construction of its SC-model, it is completely platform-independent, and can be implemented both in software and in hardware.
5. Hardware implementation involves the creation of a new generation of computing devices — semantic computers.

Рис. 2: The structure of the upper level of the ontology "History of the Polotsk Cadet Corps"

VI. CONCLUSION

In conclusion, we note the following. Ontological modeling is an important method for developing intelligent information and reference systems. By focusing on relationships between concepts and entities, this approach ensures that knowledge is represented in an intuitive and machine-readable way.

With the help of ontological modeling, one can define a subject area, develop a conceptual model, create and populate an ontology with data, and finally put the ontology into action. Although it can be a complex process, the benefits of ontology modeling are clear: it provides a foundation for building powerful applications that address a variety of application problems.

An effective tool for building ontologies is the Protégé editor. It allows you to create classes, slots and instances, and also provides an easy way to modify ontologies without creating inconsistent data and knowledge. Protégé can be used for practical applications, such as creating ontologies for intelligent information retrieval systems,

as well as for educational purposes, such as creating ontology models for e-learning.

Note also that Protégé can be easily integrated with other software used to work with ontologies. Based on the ontology created by Protégé tools, using the OSTIS technology stack, you can quickly create an Intelligent Information Retrieval System or a digital archive of an organization.

Returning to the IIRS "History of the Polotsk Cadet Corps we note that the electronic resource created as a result of the above steps can be used in at least three organizations. In the Euphrosyne Polotskaya State University of Polotsk — as an exhibit of the Museum of the History of Science and Education of Polotsk, in the Polotsk Cadet Corps — as an exhibit of the corps museum being created, as well as in the exposition of the Polotsk National Historical and Cultural MuseumReserve . In addition, the resource will certainly find application in the educational process of Polotsk State University.

ACKNOWLEDGMENT

The author expresses his deep gratitude to Professor V. V. Golenkov, thanks to whose advice and support I decided to write this article.

REFERENCES

[1] V. V. Golenkov and N. A. Guljakina Cemanticheskaja tehnologija komponentnogo proektirovanija sistem, upravljaemyh znanijami. *Otkrytye semanticheskie tekhnologii proektirovaniya intellektual'nykh system [Open semantic technologies for intelligent systems]*, Minsk, BGUIR, 2015, pp. 57–78 (In Russ.)

[2] A. Maedche, B. Motik, L. Stojanovic, R. Studer, R. Volz Ontologies for enterprise knowledge management, *IEEE Intelligent Systems,* vol. 18, No. 2, IEEE, 2003, pp.26–33.

[3] R. S. Oktari, K. Munadi, R. Idroes, H. Sofyan Knowledge management practices in disaster management: Systematic review. *International Journal of Disaster Risk Reduction*, vol. 51, Elsevier, 2020, pp. 10–18.

[4] V. A. Carriero, A. Gangemi, M. Aldo, M. L. Mancinelli, L. Marinucci, A. G. Nuzzolese, V. Presutti, C. Veninata. ArCo: The Italian cultural heritage knowledge graph. The Semantic Web– ISWC 2019: 18th International Semantic Web Conference, Auckland, New Zealand, October 26–30, 2019, Proceedings, Part II 18, Springer, 2019, pp. 36–52.

[5] M. L. Turco, M. Calvano, E. Giovannini Data modeling for museum collections. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, vol. 42, No. 2, 2019

[6] A. Vlachos, M. Perifanou, A. Economides A review of ontologies for augmented reality cultural heritage applications. *Journal of Cultural Heritage Management and Sustainable Development,* Emerald Publishing Limited, 2019.

[7] M. N. Buharov Informacionnaja sistema dlja ontologicheskogo modelirovanija predmetnyh oblastej [Information system for ontological modeling of subject areas]. *Journal of Cultural Heritage Management and Sustainable Development,* Informatika, vol. 19, No. 2, 2022 (In Russ.)

[8] S. P. Vorona, E. O. Savkova Ispolzovanie ontologicheskogo modelirovanija pri razrabotke intellektual'noj sistemy dostupa k uchebno-metodicheskoj informacii [The use of ontological modeling in the development of an intelligent system for access to educational and methodological information]. Informatika, upravljajushhie sistemy, matematicheskoe i komp'juternoe modelirovanie (IUSMKM-2020), 2020, pp. 208–213(In Russ.)

[9] E. Kalashnikov, V. Pavlenko Primenenie ontologicheskogo modelirovanija v raznyh otrasljah [Application of ontological modeling in different industries], XXV Nauchno-tehnicheska konferencija s mezhdunarodnym uchastiem sbornik dokladov, P. 97 (In Russ.)

[10] J. A. Balyberdin Ontologicheskoe modelirovanie predmetnyh znanij v vuzah, konstruktorskih bjuro i nauchno-issledovatel'skih institutah [Ontological modeling of subject knowledge in universities, design bureaus and research institutes], 2022 (In Russ.)

[11] B. Reitemeyer, H.-G. Fill Enterprise, Business-Process and Information Systems Modeling: 20th International Conference, BPMDS 2019, 24th International Conference, EMMSAD 2019, Held at CAiSE 2019, Rome, Italy, June 3–4, 2019, Proceedings 20, Springer, 2019, pp. 212–226

[12]] Z. A. A. Salam, R. A. Kadir, A. Azman Ontology Merging Using PROTÉGÉ–a Case Study. *Journal of Information System and Technology Management*, JISTM, 2021

[13] C. Shimizu, K. Hammar, P. Hitzler Modular graphical ontology engineering evaluated. The Semantic Web: 17th International Conference, ESWC 2020, Heraklion, Crete, Greece, May 31–June 4, 2020, Proceedings 17, Springer, 2019, pp. 20–35

[14] E. V. Glazyrin, T. E. Sohor Polockij kadetskij korpus v otkrytyh pis'mah, vypushhennyh «Obshhestvom vzaimopomoshhi polochan» v nachale XX veka [Polotsk cadet corps in open letters issued by the Polokhan Mutual Aid Society at the beginning of the 20th century], 2019 (In Russ.)

[15] S. G. Ljutko Stanovlenie i razvitie voennogo obrazovanija na zemljah Belarusi v XVIII–nachale XX veka [Formation and development of military education on the lands of Belarus in the XVIII — the beginning of the XX century], Minskij gosudarstvennyj lingvisticheskij universitet, 2021 (In Russ.)

[16] S. Poljakov and others Polockij kadetskij korpus. Istorija v licah [Polotsk cadet corps. History in faces], Matjeryjaly navukovapraktychnaj kanferjencyi: pa vynikah navukova-dasledchaj raboty 2008 g, NPIKZ, 2009, pp.48–59 (In Russ.)

[17] V. P. Vikent'ev Polockij kadetskij korpus. Istoricheskij ocherk 75- letija ego sushhestvovanija [Polotsk cadet corps. Historical sketch of the 75th anniversary of its existence], Polock: Tip. XV Kljachko, 1910 (In Russ.)

[18] V. V. Golenkov, N. A. Gulyakina, I. T. Davydenko, D. V. Shunkevich Semantic technologies of intelligent systems design and semantic associative computers. *Doklady BGUIR*, 2019, No. 3, pp. 42–50

[19] V. V. Golenkov, N. A. Gulyakina, V. A. Golovko, V. V. KrasnoproshinMethodological problems of the current state of works in the field of Artificial intelligence. *Otkrytye semanticheskie tekhnologii proektirovaniya intellektual'nykh system [Open semantic technologies for intelligent systems]*, 2021, vol. 5, pp. 17–32

Создание комплексного цифрового архива полоцкого кадетского корпуса: пример проектирования интеллектуальной информационно-справочной системы

Оськин А. Ф.

На примере проектирования и построения Интеллектуальной информационно-поисковой системы (ИИПС) «Полоцкий кадетский корпус» описаны основные этапы создания ИИПС. Кратко рассмотрены принципы онтологического моделирования и инструменты, используемые для этих целей. На основе анализа предметной области строится онтологическая модель, которая может быть преобразована в работающую ИИПС с использованием стека технологий OSTIS. Описаны преимущества технологий OSTIS для решения задач подобного рода.

Received 27.03.2023

An Automated Approach to Checking User Knowledge Levels in Intelligent Tutoring Systems

Wenzu Li
Belarussian State University Informatics and Radioelectronics, Минск, Беларусь
Минск, Беларусь
lwzzggml@gmail.com

***Abstract*—This article is dedicated to the issue of automating the implementation of rapid testing of user knowledge in new generation intelligent tutoring systems. A semantic-based approach to automating the entire process from test question generation and test paper generation to the automatic verification of user answers and the automatic scoring of test papers is described in detail in this article.**

***Keywords*—testing user knowledge level, test question generation, user answer verification, intelligent tutoring systems, test paper generation, automatic scoring of test papers**

I. INTRODUCTION

Educators have long shared a common desire to use computers to automate teaching and learning services. In recent years, with the development of artificial intelligence technology, this wish is likely to become a reality. The most representative product combining artificial intelligence and education is the intelligent tutoring system (ITS), which can not only improve the learning efficiency of users, but also ensure the fairness and impartiality of the education process [9].

Automatic generation of test questions and automatic verification of user answers are the most basic and important functions of ITS. Using these two functions in combination will enable the entire process from the automatic generation of test questions to the automatic scoring of the user test papers. This will not only greatly reduce the repetitive work of educators, but will also reduce the cost of user learning, thus providing more users with the opportunity to learn various knowledge [1], [2], [7].

Although in recent years, with the development of technologies such as the semantic web, deep learning and natural language processing (NLP), several approaches have been proposed for the automatic generation of test questions and the automatic verification of user answers, these approaches have the following main disadvantages:

- existing approaches to generating test questions allow only the simplest objective questions to be generated;
- some existing approaches (for example, keyword matching and probability statistics) to verifying user answers to subjective questions do not consider the semantic similarity between answers;
- methods that use semantic to verify user answers to subjective questions can only calculate similarity between answers with simple semantic structures [7], [8], [10].

Objective questions usually have a unique standard answer. In this article, objective questions include: multiplechoice questions, fill in the blank questions and judgment questions. Objective questions differ from subjective questions, which have more than one potential correct answer. Subjective questions in this article include: definition explanation questions, proof questions and problemsolving task.

Therefore, based on existing methods and OSTIS Technology, an approach to developing a universal subsystem for automatic generation of test questions and automatic verification of user answers in tutoring systems developed using OSTIS Technology (Open Semantic Technology for Intelligent Systems) is proposed in this article [1], [2], [5]. The universality of the subsystem means that the developed subsystem can be easily transplanted to other ostis-systems (system built using OSTIS Technology). The developed subsystem allows the use of the knowledge bases of the ostis-systems to automatically generate various types of test questions and automatically verify the completeness and correctness of user answers based on the semantic description structures of the knowledge. The discrete mathematics ostis-system will be used as demonstration systems for the developed subsystem.

II. EXISTING APPROACHES AND PROBLEMS

A. Automatic generation of test questions

Approach to automatic generation of test questions mainly studies how to use electronic documents, text corpus and knowledge bases to automatically generate test questions. Among them, the knowledge base stores highly structured knowledge that has been filtered, and with the development of semantic networks, using the knowledge base to automatically generate test questions has become the most important research direction in