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KNOWLEDGE PROCESSING TECHNOLOGIES IN THE AREA OF COMPUTER SCIENCE

ИНФОРМАТИКА САЛАСЫНДАҒЫ БІЛІМДІ ӨҢДЕУ ТЕХНОЛОГИЯЛАРЫ

ТЕХНОЛОГИИ ОБРАБОТКИ ЗНАНИЙ В ОБЛАСТИ ИНФОРМАТИКИ

Abstract. *The research paper discusses the methods of creating, applying and analyzing knowledge bases with a description of subject areas. The methods considered apply an integrated approach to knowledge representation.*

We propose an approach to developing an intelligent system designed to tackle intricate problems. This approach is built upon semantic models of knowledge bases and coherent models of machines dedicated to processing these knowledge bases. The foundation for constructing these models lies in a unified semantic representation of knowledge, grounded in universal semantics with a theoretical aspect of multiple interpretations. Using this language as a basis, we construct an open family of collaborative languages, where the meaning of each language is determined by an appropriate ontological approach.

The semantic model for machine processing of fundamental knowledge adopts the concept of multiagents, facilitating interactions among agents through shared semantic memories. This article serves as a comprehensive introduction to utilizing Protégé as a tool for ontology building in the field of computer science. It provides practical recommendations and insights into the software's advantages and limitations. Researchers and practitioners in computer science seeking a convenient and powerful tool for ontology development will find this article beneficial.

In order to more effectively develop knowledge in the field of computer science, the author defines the classification of knowledge, explains the choice of ways to develop knowledge, analyzes forms, methods of control depending on the information approach.

Keywords: knowledge base, information technology, computer science, integrated method, knowledge development, semantic modeling.

Аңдатпа. *Мақалада пәндік салаларды сипаттай отырып, білім қорын құру, қолдану және талдау әдістері қарастырылған. Қарастырылған әдістер білімді ұсыну үшін интеграцияланған тәсілді қолданады.*

Білім базаларының семантикалық модельдері, сондай-ақ білім базаларын өңдеуге арналған

машиналардың келісілген модельдері негіз болатын кешенді сипаттағы мәселелерді шешуге бағытталған интеллектуалды жүйені құру тәсілі ұсынылды. Бұл модельдерді құрудың негізі теориялық көптік түсіндірмесі бар әмбебап семантика негізінде білімді бірыңғай семантикалық бейнелеуде жатыр. Осы тілдің негізінде бірлескен тілдердің ашық отбасы құрылады, әр тілдің мағынасы тиісті онтологиялық тәсілмен беріледі. Білімді өңдеуге арналған негізгі машинаның семантикалық модельдеуі агенттер үшін өзара әрекеттесу оған ортақ семантикалық жады арқылы жүзеге асырылады деп болжайтын көп агенттік тұжырымдамаға негізделген.

Информатика және ақпараттық технологиялар саласындағы білімді тиімдірек дамыту үшін автор білімнің жіктелуін бөліп көрсетті, білімді дамыту әдістерін таңдауды негіздейді, ақпараттық тәсілге сәйкес нысандарды, әдістерді, бақылауды қарастырады.

Түйін сөздер: *білім базасы, ақпараттық технологиялар, информатика, интеграцияланған әдіс, білімді дамыту, семантикалық модельдеу.*

Аннотация*. В данной статье исследуются подходы к формированию, использованию и анализу баз знаний, включая описание предметных областей. Рассмотренные методы предполагают применение интегрированного подхода для представления знаний.*

Предложен новый метод создания интеллектуальной системы, ориентированной на решение сложных задач. Основой этой системы являются семантические модели баз знаний и согласованные модели машин для их обработки. Эти модели строятся на общем смысловом представлении знаний, основанном на универсальной семантике с теоретической множественной интерпретацией. На основе этого подхода создается открытое семейство совместных языков, где каждый язык определяется соответствующим онтологическим подходом. Семантическое моделирование базовой машины для обработки знаний основано на многоагентной концепции, предполагающей взаимодействие агентов через общие семантические памяти.

Для более эффективного развития знаний в области информатики и информационных технологий автор выделяет классификацию знаний, обосновывает выбор методов их развития, а также рассматривает формы, методы и контроль в соответствии с информационным подходом.

Ключевые слова: *база знаний, информационные технологии, информатика, интегрированный метод, развитие знаний, семантическое моделирование.*

Introduction. The significance of this topic stems from the distinction between computer memory contents and human knowledge, highlighting the intricate nature of the former. Despite their complexity, computer memory contents can serve as valuable models for communication, although they do not equate to human knowledge. This fundamental understanding underpins expert systems, where the intelligent systems of today mark a natural progression in the evolution of computer systems. This evolution encompasses the representation and processing of information within computer memory models.

Problem Statement:

Exploring methods for constructing, utilizing, and analyzing knowledge bases

Analyzing the chosen subject

The aim of this article is to develop and explore a methodological framework for producing knowledge in the field of information and communication technologies. This strategy utilizes cognitive visualization techniques to investigate models of information processing.

Materials and methods of research. Knowledge processing techniques play a crucial role in enabling the engagement, depiction, and application of pervasive intelligence within metasynthesis-driven problem-solving in m-spaces. Key challenges in knowledge processing within m-spaces include:

– Mechanisms for capturing and portraying unstructured and uncertain knowledge, such as empirical knowledge residing in the minds of domain experts, involving unstructured knowledge representation and brain informatics.

– Mechanisms for acquiring and representing expert thought processes, encompassing imaginative and creative thinking in collaborative heuristic discussions.

– Mechanisms for capturing and representing group/collective interaction behaviors and their impact, involving behavior informatics and analytics.

Mechanisms for modeling learning-of-learning, which involves understanding and adapting to the behaviors of other participants resulting from self-learning or external learning, such as learning evolution and the emergence of intelligence.

Furthermore, in general open complex intelligent systems, knowledge processing entails addressing additional critical issues:

Knowledge fusion, which integrates both empirical and structured knowledge acquired, reasoned, and discovered.

Mechanisms to facilitate knowledge representation and integration into m-space through m-interaction.

Mechanisms for handling inconsistency in knowledge at the semantic level (Nguyen 2005).

Searching, retrieving, and mining structured information from unstructured or ill-structured data and information.

Adapting processed knowledge, including identified patterns and decisions, for practical applicability in real-world situations.

Development of mechanisms and systems for metasynthesis computing (m-computing), involving engineering approaches for the analysis, design, and implementation of M-Space and M-Interaction [9].

Processing knowledge and representing knowledge are the central requirements for artificial intelligence systems. Many tasks in computer science, in particular those dealing with natural and inherently noisy environments, involve high degrees of complexity in actually perceiving, understanding and transferring available information. This lecture will present methods for processing and representing knowledge from a theoretical as well as from an application-oriented perspective. Theoretical principles find practical application in various domains such as common sense reasoning, intelligent handling of imprecise or uncertain data, smart planning, language processing, and the development of intelligent agents. These agents are designed for virtual entities, real-world robots, and autonomous individuals within multi-agent systems. Current implementations of these theoretical concepts are translating into tangible advancements in knowledge-based software solutions and robotic systems, enhancing their capability to perform everyday tasks.

Books have served as the primary source of information for an extended period. The search tool acts as an individual's gateway to the repository of books. Searching for information used to be a time-consuming process because the focus was not on obtaining the entire book, but rather a specific fragment. It was challenging to articulate the connection between the desired knowledge and the book's title or author. Due to the advancement of science, the priority given to different sources of information has changed (Fedotova, E.L., 2013).

Note that the new version of Exactus has a high-performance cluster installation under the Unix operating system. ISA specialists have reworked the Exactus architecture ONCE and created a cross-platform system.

Also, to solve the problem of semantically related search, you can use Exactus, a relatively recent search engine that appeared in 1998. What existed at that time in the search giants—Altavista and Inktomi. Currently, Google and Fast have the largest number of indexed pages (more than 2 billion).

In the next few months, Google search engines will acquire new features, in particular, they will learn how to answer user questions. As a result of the search, links to specific resources and answers to queries appear, which you can view without clicking on the link (Kalugyan K.H., 2020).

Thanks to the "restructuring", search engines can respond to quite complex tasks, for

example, the query "Lake Tahoe" allows the user to obtain data on the location of the lake without visiting additional sites.

Innovation has become feasible through the utilization of "semantic technology." Google, in responding to queries, examines the meanings of the words within the search and retrieves relevant information from a specialized database.

It is important to highlight that Google has already addressed basic queries, such as displaying stock prices, providing weather updates, and performing arithmetic operations.

The fundamental components of an intelligent system include its knowledge base, encompassing all information utilized during its operation, and the processing machinery linked to this knowledge base, embodying the system's functionality. The expansion of applications for intelligent systems requires addressing complex problems, each demanding the coordinated use of diverse representation models and knowledge processing techniques (Shihnabieva T.Sh., 2018).

To achieve these goals, systematic, statistical, and multifactorial analyses serve as research tools. The methods of theoretical analysis and solution systematization are also applied. Proficiency in concepts and techniques related to knowledge processing, including knowledge representations and integration in practical scenarios, is imperative. This knowledge prepares individuals for subsequent modules that delve into knowledge processing using neural networks, language processing, computational vision, robotics, and human-computer interaction, as well as various projects and master theses.

The field of computer science has experienced rapid growth, leading to an exponential surge in generated and processed information. Consequently, there is a critical need for effective methods of organizing and managing this information. Ontologies, which offer a formal representation of concepts and their relationships within specific domains, have emerged as valuable tools to address these challenges. By structuring domain knowledge systematically, ontologies enable knowledge sharing, reasoning, and the development of intelligent information systems.

Literature review and problem statement. The field of ontology in computer science has witnessed significant interest and engagement from researchers in recent decades. Numerous studies have been conducted, focusing on ontologies' creation, utilization, and application in diverse fields. Important references in this field encompass "The Handbook on Ontologies in Information Systems," which presents a thorough exploration of the conceptual and methodological dimensions of ontologies. It also delves into the creation and utilization of ontologies across diverse domains. The work "Ontologies: Principles, Methods and Applications", authored by Mike Uschold and Michael Gruninger, discusses the basic principles and methods of creating ontologies, as well as the application of ontologies in various fields, such as biomedicine, finance and others.

Also, the study of various aspects of ontologies was carried out by such domestic and foreign authors as:

Mike Uschold and Michael Gruninger's work, "Ontologies: Principles, Methods, and Applications," explores the fundamental principles and methodologies involved in ontology creation, along with their practical applications in domains such as biomedicine and finance. In addition to these seminal works, a wide range of domestic and international authors have contributed to the understanding of various aspects of ontologies, including Gulnara Kabanova and Harald Gall ("Ontology-driven software engineering"), Belousova I.D., Kurzaeva L.V., Laktionova Yu.S., and Agdavletova A.M. ("Ontological model of requirements management in the process of professional training of IT specialists"), Johannes De Bruin and Martin Stokhof ("A survey of ontology evaluation techniques"), Omar Malik and Satish Tandon ("Ontology engineering: A survey and future directions"), Yan Hender and James Hendler ("Ontologies in biomedical research"), Fausto Giunchiglia and Maurizio Petrone ("Ontology-based information retrieval"),

among others.

Within the literature on artificial intelligence, numerous definitions of ontology exist, often conflicting with each other. In computer science, ontology is an attempt to comprehensively and precisely formalize knowledge within a specific domain, employing a conceptual framework. The term "ontology" in computer science is derived from its ancient philosophical concept, which studies the fundamental principles of existence, general essences, categories, structure, and patterns (Kalugyan K.H. 2020).

In the context of this article, ontology refers to a formal and explicit description of concepts within a specific subject area, encompassing classes (also known as concepts), properties (describing various attributes of concepts, referred to as slots or roles), and constraints imposed on these slots (facets or role constraints) [3]. Together with a collection of individual instances of classes, an ontology forms a knowledge base, blurring the distinction between ontology and knowledge base boundaries.

While ontology can be discussed in philosophy as a theory of existence, for instance, Aristotle's ontology with its primitive categories like substance and quality, in computer science, it is a technical term denoting an artifact designed to model knowledge about a real or imaginary subject area for specific purposes. This concept was embraced by early artificial intelligence researchers, who recognized the relevance of work from the field of mathematical logic (Shihnabieva T.Sh.2018) and proposed creating new ontologies as computational models enabling automated reasoning (Dzharratano Dzh., 2006). In the 1980s, the artificial intelligence community started using the term "ontology" to refer to both the theory of simulated worlds (e.g., naive physics) and the knowledge system component. Some researchers, inspired by philosophical ontologies, regarded computational ontology as a form of applied philosophy.

Ontology defines a common vocabulary for scientists who need to share information in a subject area. It includes machine-interpreted formulations of the main concepts of the subject area and the relationships between them.

What prompts the creation of an ontology? Various reasons include:

– Establishing a shared comprehension of information structure among individuals or software agents.
– Facilitating the potential reuse of knowledge within a specific domain.
– Explicitly articulating assumptions within the designated subject area.
– Distinguishing subject area knowledge from operational knowledge.
– Enabling the examination of knowledge within the defined subject area.

Comparative Analysis of Ontology Creation Tools. Table 1 provides a comprehensive comparative analysis of ontology creation tools, namely WebProtege, TopBraid Composer, Pronto Studio, and Protege. The table highlights the key features and functionality of each tool, facilitating an evaluation of their suitability for ontology development in various contexts.

Table 1. Comparative Analysis of Ontology Creation Tools

№	Criteria	WebProtege	TopBraid Composer	Pronto Studio	Protege
1	User Interface	Web-based, intuitive	Desktop application	Desktop application	Desktop application
		with customizable layouts	with customizable layouts	with customizable layouts	with customizable layouts
		and interactive features	and interactive features	and interactive features	and interactive features

2	Features and Functionalities	OWL, RDF, reasoning	OWL, RDF, reasoning	OWL, RDF, reasoning	OWL, RDF, reasoning
		capabilities, ontology	capabilities, ontology	capabilities, ontology	capabilities, ontology
		visualization options	visualization options	visualization options	visualization options

End of table 1

3	Collaboration and Versioning	Collaboration features,	Collaboration features,	Collaboration features,	Collaboration features,
		user permissions,	user permissions,	user permissions,	user permissions,
		version control mechanisms	version control mechanisms	version control mechanisms	version control mechanisms
4	Performance and Scalability	Efficient ontology	Efficient ontology	Efficient ontology	Efficient ontology
		loading and editing,	loading and editing,	loading and editing,	loading and editing,
		reasoning performance	reasoning performance	reasoning performance	reasoning performance
5	Interoperability and Standards Compliance	Standards compliance,	Standards compliance,	Standards compliance,	Standards compliance,
		import/export in various	import/export in various	import/export in various	import/export in various
		formats, SPARQL support	formats, SPARQL support	formats, SPARQL support	formats, SPARQL support
6	Support and Community	Documentation, user	Documentation, user	Documentation, user	Documentation, user
		community, professional	community, professional	community, professional	community, professional
		support and training	support and training	support and training	support and training
7	Cost and Licensing	Open-source	Commercial	Commercial	Open-source

Note – compiled by the author (Maxutova K.M)

This table of comparative analysis provides a means for researchers and practitioners to assess and compare WebProtege, TopBraid Composer, Pronto Studio, and Protégé in terms of their features, functionality, collaboration capabilities, performance, interoperability, support, and licensing aspects. It serves as a valuable tool for choosing the most appropriate ontology creation tool tailored to specific project needs and preferences. Overall, the comparative analysis indicates that the choice of ontology creation tools depends on specific project requirements, user expertise, collaboration needs, and budget constraints. Each tool presents its own strength and limitations, catering to diverse user preferences and project complexities. Researchers and practitioners are encouraged to carefully evaluate the features and characteristics of each tool to select the most suitable one for their ontology development endeavors.

The choice of the Protégé ontology creation tool for this study was based on its longstanding reputation, extensive feature set, and active user community. Protégé offers a comprehensive suite of tools and functionalities for ontology development, including ontology editing, reasoning, visualization, and plugin support. Its open-source nature allows for customization and flexibility, making it a popular choice among researchers and practitioners in the ontology engineering field.

Results and discussion. The research conducted in this study provides valuable insights into the fundamental concepts and principles underlying ontologies, as well as an in-depth examination of the capabilities and functionalities of the Protégé ontology editor. Through a comprehensive analysis of existing literature, a solid foundation was established for understanding ontology construction in computer science. The research findings highlight the importance of ontologies in facilitating knowledge sharing, reasoning, and the development of intelligent information systems. A thorough exploration of the Protégé tool revealed its comprehensive set of functions and tools for ontology creation and editing. The tool's interfaces, features, and tools were extensively examined, enabling researchers and practitioners to effectively utilize Protégé in ontology development. The research results demonstrate Protégé's compatibility with ontological languages such as OWL and RDF, its efficient ontology loading and editing capabilities, as well as its support for reasoning and visualization (Brewster, C., Alani, H., Dasmahapatra, S., & Wilks, Y. 2004).

As mentioned above, even in the field of computer science, there are types of ontologies that provide fundamental concepts and relationships. It is called the upper ontology. Sometimes upper ontology is also called upper-level ontology or simply ontology, which tries to connect the general concepts of the concept of reality in our world. These ontologies are the main communication to facilitate the integration of information and knowledge. Thus, many attempts have been made to create higher ontologies in the Kazakh language, and the course "Informatics" has been studied as a subject area. The value of this work is the course "Informatics" in the Kazakh language, which is posted on the internet for the first time. Using this ontology, you can see the thesaurus, the ontological model and their relationship in the Kazakh language. This thesaurus contains all the information on the topics of the course "Computer Science" for automatic text processing. Ontology reflects the semantic structure of the educational process. The application application is designed to support its management-oriented form. The conceptual part of the ontology diagram is presented in the Protege-OWL Editing ontology. Let us remind you that a thesaurus is a dictionary in which words and phrases with similar meanings are grouped together, called concepts or descriptors, and the semantic relationships between these concepts (concepts, descriptors) are clearly expressed. Relationships (in the form of hierarchies) are shown. As an example, we can take CSO, where each term has a definition, hyperonym, hyponym, holonym, meronym. Hyponyms are a concept that expresses the importance of secrecy in relation to other, more general concepts. For example, the hyponym of the word information means – Signal, report, message, source. A hyperonym is an extended meaning of the plural form of a word or name. For example, the hyperonym of confidential information is information. Meronym is a particle of the whole word. For example, the term document is length, entropy, bit, cipher, data. Holonym-object of the second meaning. For example, a synonym for documented information is information. The thesaurus is needed to determine the structure of an ontological model that defines the following fields (Figure 2): 1) terms (concepts); 2)definition (interpretation) of terms; 3) relationships and properties between them. (A.Sharipbay, Al. Aktayeva, R. Niyazova 2019).

When creating a thesaurus in the field of "computer science", more than 600 terms were collected, the definitions, connections and properties of which were given. The relationship between

these descriptors Figure 2 shows the terms of different authors in the subject area "Computer Science", consisting of nouns, definitions, hyperonyms, hyponyms, holonyms, meronyms.

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Зат есім	Түсіндірме/ Жауап
Ақпарат	Адамның (санасына | қабылдауына) байланыссыз қоршаған дүниедегі материалдық немесе материалдық емес объектілер және субъктілер касиеттерінің және қатынастарының (бейнесі | белгісі)
Хабар	Ақпарат (формасы | пішімі)
Мазмұн	Әр түрлі қатынас тіліндегі баяндама
Жіберуші	Ақпарат жіберетін адам
Қабылдаушы	Ақпарат қабылдайтын адам
Информатика	Компьютер және одан басқа да техникалық құрылғылар көмегімен ақпараттарды алу, сақтау, өзгерту, жеткізу және оны пайдалану заңдылықтарын, (тәсілдерін | әдістерін), жолдарын зерттейтін ғылым саласы
(Сигнал | Дабыл)	Элементарлық екілік (дабыл | сигнал) бір бит ақпаратты (тасушы | жеткізуші)
Таңба	Есептеуіш техникасында қолданылатын (алфавиттің | әліпбидің) жеке символы
(Процесс | Үдеріс)	(Программа | Бағдарлама) және оның жұмыс (істеуіне | жасауына) қажетті жүйелік ресурстар
Техника	Өндіріс (процестерін | үдерістерін) жүзеге асыру құралдарының (жиынтығы | жиыны)
(Әліпби | Алфавит)	Белгілі бір тілдің кез келген сөздерін құрайтын символдарының (жиынтығы | жиыны)
Символ	Таңбалық жағдайда басқа объектінің орнына қолданылатын объект
(Программа | Бағдарлама)	Машина тілі түсінетіндей, (командалар | пәрмендер) тізбегі түрінде жазылған алгоритм
Ресурс	(Процеске | Үдеріске) немесе (пайдаланушыға | қолданушыға) бөлінетін (есептеуіш жүйенің | есептеу жүйесінің) логикалық немесе физикалық бөлігі
Операция	(Қандай да | Белгілі) бір нәтижеге жету немесе тапсырманы орындау үшін қолданылатын әрекет
Логика	Ойлау және оның (формалары | пішімдері) мен заңдылықтары туралы ғылым
Машина тілі	Мазмұны мен ережелері аппараттық құралдармен орындалатын (программалау | бағдарламалау) тілі
Машина	Адам ойлау және физикалық жұмысын жеңілдету үшін арналған өзара байланысқан элементтер (жиынтығы | жиыны)
(Команда | пәрмен)	Параметрлері бар, орындалуға жіберілетін (программа | бағдарлама) аты

Figure 1. interpretation of terms and terms of the subject area of Computer Science
Note – compiled by the author (Maxutova K.M)

Figure 2. Descriptors of the subject area "Computer Science"
Note – compiled by the author (Maxutova K.M)

As an example, the lexical analysis of the term information can be seen in Figure 3.

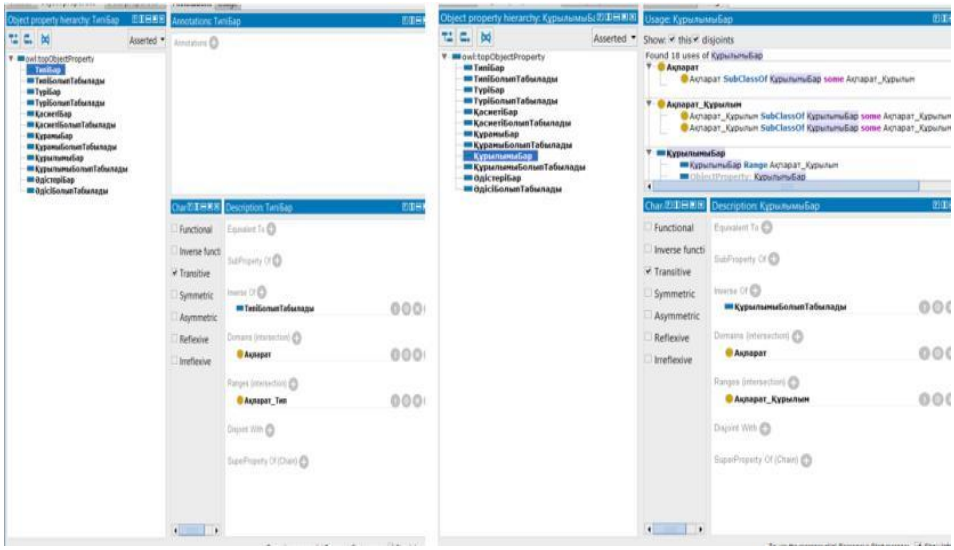

Figure 3. Semantic relationships between lexical units.
Note – compiled by the author (Maxutova K.M)

Ontology is a formal description of a particular subject area, which describes the concepts (terms) of the subject area, the relationship between them and can be represented by the following set:

$$O = <X, R, F>, \quad (1)$$

where X – is the last set of concepts (concepts, terms) of the metric area expressed by the ontology; R – is the last set of relationships between the concepts (concepts, terms) of a given subject area; F – is the last set of explanatory functions defined for concepts and/or relationships, presented as a verbal interpretation of a term, formula or term Now we will build an ontological model of the subject area “Informatics” in the Kazakh language, which will allow us to accumulate and store knowledge for a long time, as well as easily change and supplement them. To create an ontological model, we chose the Protégé Program, which is widely used. Figure 4 shows the connections established between the terms of the subject area “Informatics” in the Kazakh language in the Protege environment and its subclasses.

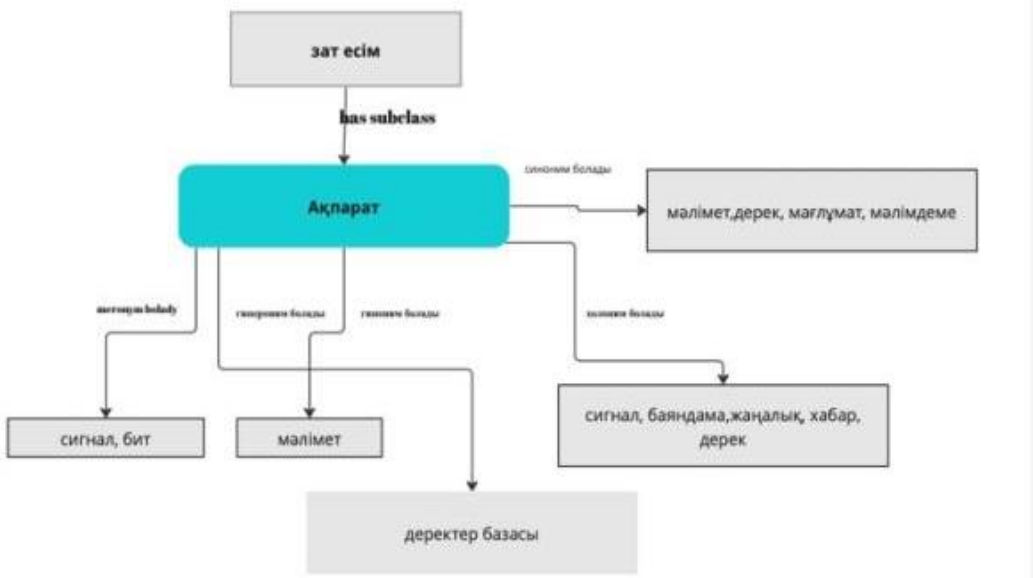

Figure 4. Terms and its subclasses created in the Protégé Program
Note – compiled by the author (Maxutova K.M)

To create a specific ontology that meets the requirements, the ontology development methodology was used. This methodology was chosen because it guides the ontology development process, as well as other support and management activities. We see that the aspects of these models are sometimes hybrids, since they all include aspects of both theories to show that they are included in the ontology sentence. In addition, the assembly of an ontology is based on the "classical" methodologies of software development, and this makes it easier for people with experience in software development to learn and use it. Also, activities such as evaluation, integration or coordination of other ontologies, documentation and configuration management have been carried out at the same time to apply knowledge-oriented ontologies. These are all auxiliary actions, and the main work on creating an ontology is carried out in the development process. Figure 5 shows the ontological model of the Kazakh language in the subject area" Informatics".

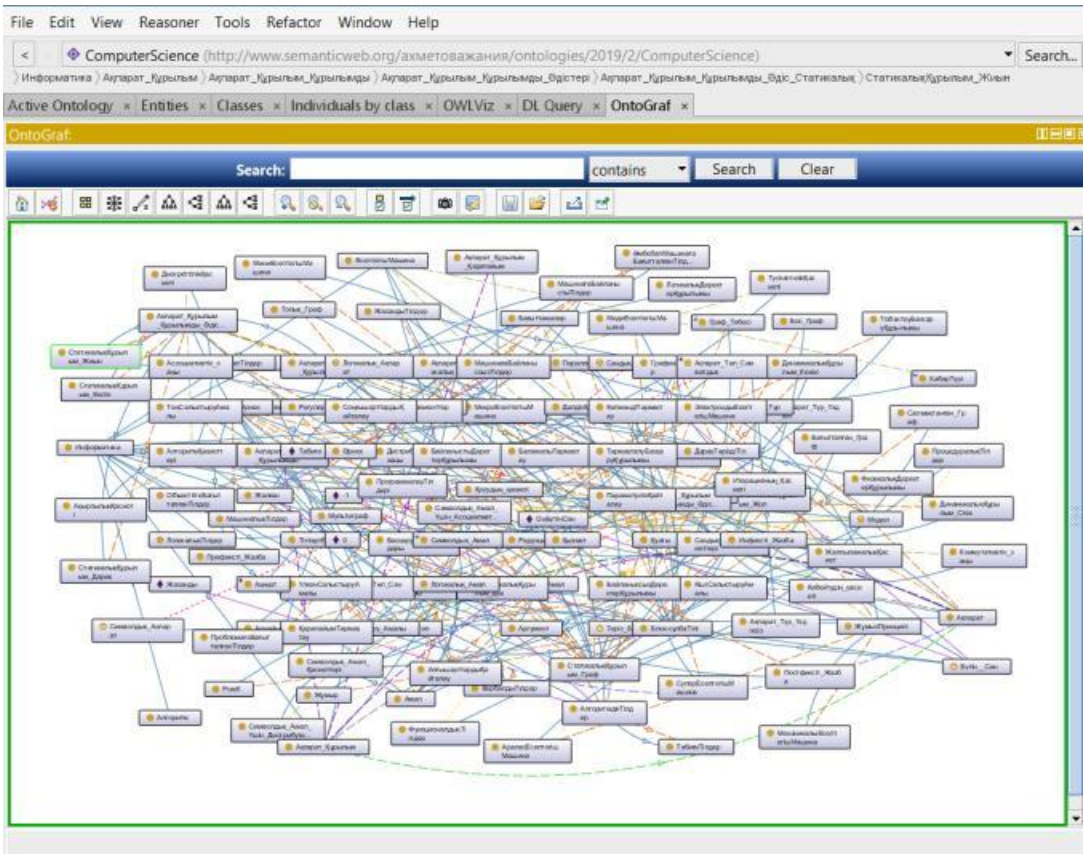

Figure 5. Ontology of the general typology of the thesaurus of terms
Note – compiled by the author (Maxutova K.M)

As a result of the study, a systematic, accurate knowledge base for school classes in the Kazakh language was created for the first time on the basis of web ontology in the subject area of computer science. The proposed hypothesis gave the expected result, and with the help of the developed Protégé Program, the Kazakh-language web ontology in computer science will contribute to the scientific development of computer science. Discussion. Ontology is interpreted as a way of providing the necessary mechanisms for modeling reality and connects students with their motivation to respond, but it does not commit to a specific way of organizing responses. Knowledge representation is achieved through the use of web ontology language (OWL) and semantic web language designed to represent knowledge about groups of things, relationships between things, rich and complex things. OWL is a language based on computational logic, according to which computer programs can use the knowledge expressed in OWL and also facilitate the sharing, reuse of knowledge using the global internet infrastructure. Therefore, the article presents a web-based ontology of the ontological model of knowledge in the Kazakh language in the subject area "Informatics". A feature of this work in the field of ontology is the creation of a specific knowledge base for school classes in the subject area of computer science, created in the Kazakh language. According to the school course" Informatics", an analysis of books of grades 5-11, textbooks and educational and methodological literature of such publishing houses as Almaty publishing house, Armandpv, atamura was carried out, subject areas and basic concepts were identified. Figure 6 analyzes the computer science textbook for Grade 5 and shows Terms and connections on topics.

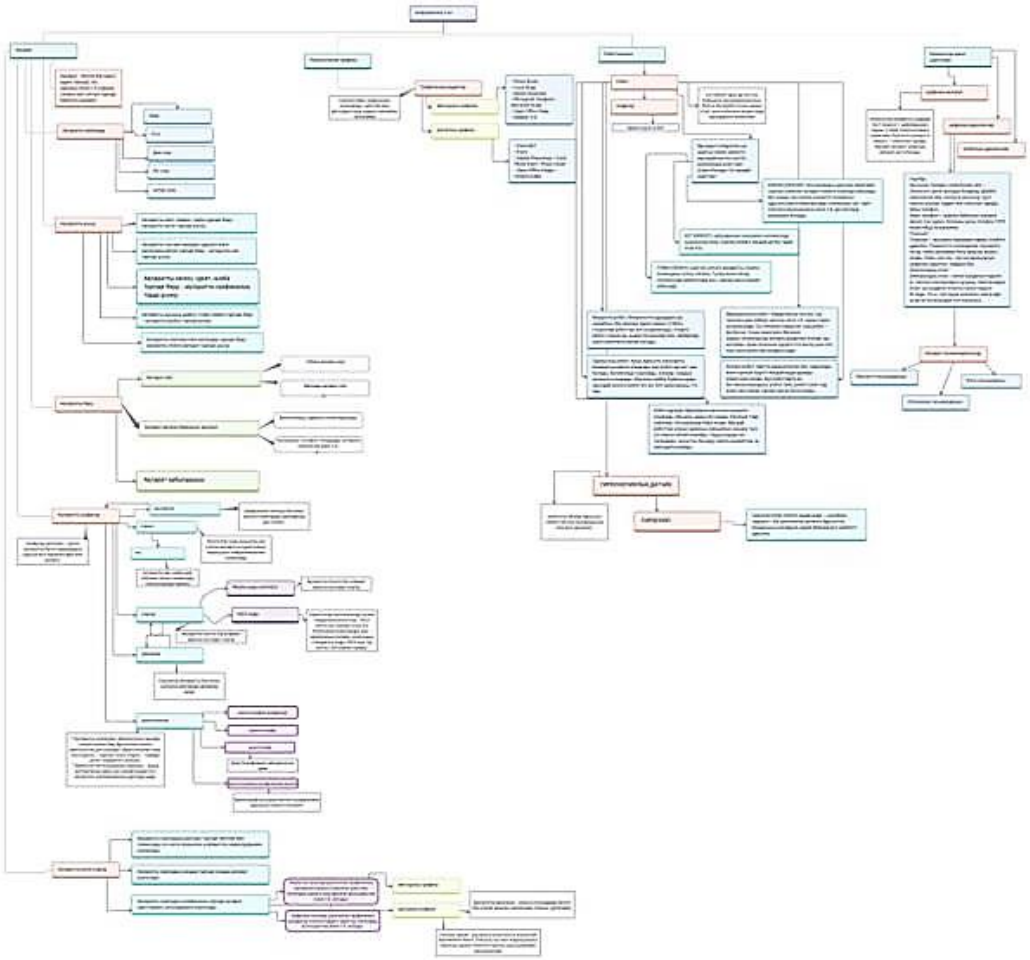

Figure 6. Structure of the 5th grade computer science discipline

Note – compiled by the author (Maxutova K.M)

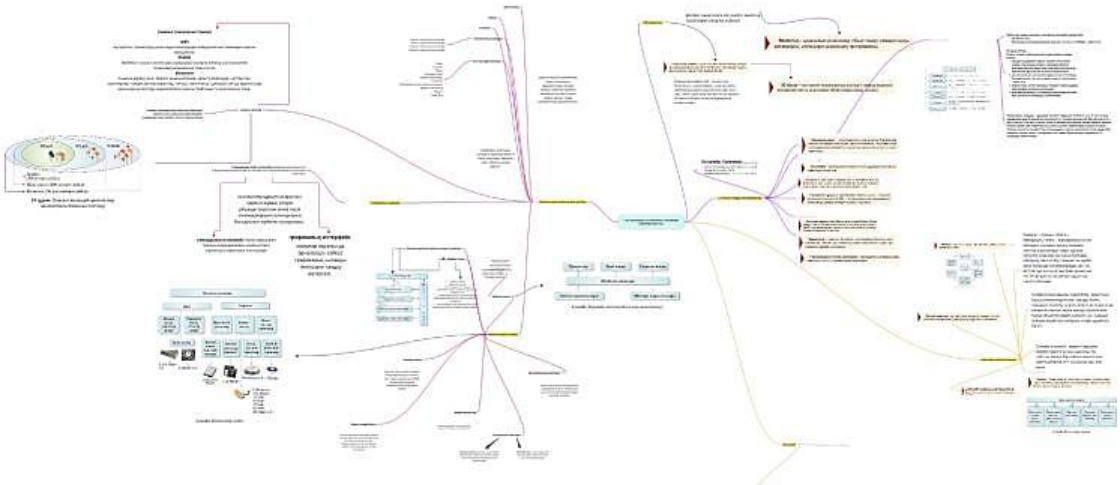

Figure 7. Structure of the subject of Computer Science Class 6

Note – compiled by the author (Maxutova K.M)

In addition, in Figure 3, remembering the lexical analysis of the term "information", one can see the correctness of the developed ontological model. As shown in Figure 5, the Protégé Program created the subject ontology of the course "Informatics" in the Kazakh language with an analysis of the ontologies of English and Russian-language Informatics. The use of such an approach as part of educational processes makes it possible to combine a large amount of existing information into a single knowledge base, which can combine several academic disciplines and be clearly distributed on the Internet, making it independent. Another important feature of such a knowledge generation system is the ability to create testing software systems that generate test tasks based on the semantics of the described ontologies. It is clear that such systems for building knowledge control are much superior to the currently existing tests aimed at choosing one of several answer options. The ontological system as a means of describing the subject area should be useful to all specialists who are faced with the problem of searching, displaying and using knowledge in their work.

Conclusion

Visualizing cognitive thinking accelerates and enhances the comprehension of information technology structures as entities, providing a more comprehensive representation of educational concepts and their interconnections.

The challenges in bringing experts to identify and resolve bugs are growing increasingly complex. Their approaches primarily focus on employing formal methods. These methods enable the incorporation of intricate relationships alongside existing ones, facilitating the description of real-world tasks and objects.

Ontological modeling is an important method for the development of intellectual educational resources. By focusing on the relationships between concepts and subjects, this approach ensures that knowledge is presented in an intuitive and machine-readable way. With the help of ontological modeling, you can identify a problem area, create a conceptual model, create and fill an ontology with data, and finally introduce an ontology into action. Although the process can be complex, the advantages of ontological modeling are obvious: it provides the basis for creating powerful applications that solve various application problems. An effective tool for creating ontologies is the protégé editor. It allows you to create classes, cells, and versions, and provides an easy way to modify ontologies without creating inconsistent data and knowledge. Protégé can be applied to practical applications, such as the creation of ontologies for Intelligent Information Retrieval Systems, as well as for educational purposes, such as the development of ontological models for e-learning. We can also mention that Protégé easily integrates with other programs used to work with ontologies. In our case, since OWL is the official language, we can see in this feature and the existing environment for the development of ontologies that we implement in Protege. In the course of the study, the following issues were studied and the results were obtained: A thesaurus on the subject "Informatics" was created and an ontological model developed in the Kazakh language. In the future, it is planned to expand the ontological model, thesaurus, as well as create an intelligent system in the subject area "Computer Science". A promising avenue of progress involves formalizing the processes for constructing well-structured knowledge bases and implementing these procedures in various computing environments, be it local or distributed. Creating a sound knowledge base can be achieved through conventional methods as well as utilizing emerging technologies like cloud computing.

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