МРНТИ 53.31.23

Zh.B. Sadirmekova[1], J.A. Tussupov[1], M.A. Sambetbayeva[1,2], Zh.T. Altynbekova[3]

[1]L.N. Gumilyov Eurasian National University, Nur-Sultan, Kazakhstan
[2]Institute of Information and Computing Technologies, Almaty, Kazakhstan
[3]Taraz Innovative Humanitarian University, Taraz, Kazakhstan
(E-mail:janna_1988@mail.ru, tussupov@mail.ru , madina_jgtu@mail.ru, janka1930@mail.ru)

Technology for building ontologies for an information system to support scientific and educational activities

Abstract. *The article presents an approach to organizing scientific portals based on ontologies. Ontology is the information basis of the Internet portal of knowledge, which should provide integration and systematization of scientific knowledge and information resources of a certain subject, as well as meaningful access to them from any "point" of Internet space. The ontology automatically builds a diagram of the portal's internal database and forms for filling it out, organizes navigation through the portal's information space, and ensures that search queries are formulated in terms of the knowledge portal's subject area. The division of the portal's ontology into subject-independent and subject-specific ontologies makes the portal customizable for almost any field of scientific knowledge. This technology allows declarative adjustment of the ontology during the operation of the knowledge portal, which allows you to track the dynamics of the emergence of new knowledge and information resources on the subject of the portal and thus provides support for its relevance and usefulness.*

Key words: *ontology, knowledge portal, integration, information system, information model.*

DOI: https://doi.org/10.32523/2616-68-36-2020-133-4-7-15

Introduction. At present, the problem of effective use of a huge amount of knowledge and information resources accumulated in various fields of human activity is very acute. However, access to this knowledge and resources is significantly limited due to the fact that they are poorly structured, poorly systematized, and dispersed across various Internet sites, libraries, and archives. At the same time, in the course of scientific activity, researchers need effective access to publications and other information resources containing descriptions of methods and approaches developed within their subject area of interest.

To meet the above-described need, the concept and architecture of a specialized Internet portal of knowledge [1] was proposed, which should provide integration and systematization of scientific knowledge and information resources of a certain subject, as well as meaningful access to them from any "point" of the Internet space. Moreover, according to this concept, the knowledge portal should provide access not only to its own information resources, but also support navigation on relevant portal resources located on the Internet.

In addition to supporting a flexible and holistic representation of the scientific discipline and various aspects of scientific activity, providing meaningful access to integrated knowledge and information resources related to this scientific direction, an important requirement for the knowledge portal is the ability to declaratively configure it for a given subject area, not only during creation, but also during operation. The ability to configure the portal will allow you to track the dynamics of the emergence of new knowledge and information resources on the subject of the portal and thus support its relevance and usefulness. The fulfillment of these requirements became possible due to the choice of the ontology knowledge portal as the conceptual basis and information model.

In this paper, we use the concept of "ontology" in the sense that it is used in computer science and artificial intelligence [2]. We believe that one of the goals of ontology is to describe and study entities that exist in the real world and/or human consciousness. For computer science and artificial intelligence systems, in particular knowledge portals, there is only what is already represented in them or can be represented, so we adhere to the definition of ontology given in [3]. According to this definition, ontology is an exact specification of conceptualization. Moreover, conceptualization is understood as an abstraction, i.e. a simplified representation of the world built for a specific purpose. Conceptualization includes objects, concepts, and other entities that are assumed to exist in the domain under consideration, as well as relationships between them.

It should be noted that [4] emphasizes that ontology is a specification of conceptualization, but only in the part that depends on a particular area of interest. In [5], it is emphasized that ontologies should help solve problems arising from the fact that there are different interpretations of the same terms in different fields. In this regard, ontology is considered as an agreement on a certain area of interest to achieve certain goals.

According to N. Guariano [6], in order to establish an agreement on knowledge represented in a certain logical language, ontology should characterize conceptualization by limiting the possible values of predicates and functions. In his understanding, ontology is a logical theory, axioms of which constrain the interpretation of the nonlogical symbols of the language.

Based on the above definitions, we can say that an ontology is an accurate detailed description (model) of some part of the world (subject area) in relation to a specific area of interest. In the context of this work, the ontology will be a description of some training courses and related scientific activities. The task of developing a technology for building ontologies for portals of scientific knowledge is very relevant. This paper is devoted to the description of our experience in creating and using such technology.

Ontology of the knowledge portal. The ontology should not only provide a formal representation of the system of concepts of the domain (SOFTWARE) of the portal, but also support all the required functionality, i.e. serve as a basis for implementing effective representation of various information on the portal's subject and meaningful access to it, as well as support the integration of relevant information resources into the portal's information space and convenient navigation through it. To effectively represent SOFTWARE knowledge, ontology must provide a description of concepts with a complex structure and a variety of semantic relationships between them. An important requirement for the portal ontology is the ability to build concepts of the subject area in the hierarchy "General–private" and support inheritance of properties in this hierarchy.

Since the ontology should serve the purpose of meaningful declarative configuration of the portal for a given area of knowledge and support all its functionality, it should be organized in such a way that it can automatically build a diagram of the portal's internal database, forms for filling the portal database with data, a navigation scheme for the portal's information space, and search query forms. To simplify configuring the portal for the selected area of knowledge in the ontology, you must select structures that are independent of the portal's subject area. In addition, the ontology must have properties such as extensibility and integrability with existing ontologies.

An ontology of the knowledge portal that meets the requirements described above can be formally defined by a seven of the form:

$$O=\langle C, A, R_C, T, D, R_A, F\rangle$$

where C – is a set of classes describing concepts of a particular subject or problem area; A – is a set of attributes describing properties of concepts and relationships; $R_C=\{r_c \mid r_c \subseteq C \times C\}$– a set of relations defined on classes (concepts); T – a set of standard attribute value types (string, integer, real, date); D – a set of domains (sets of values of the standard string type); $R_A = R_{AT} \subseteq R_{AD}$, where $R_{AT} \subseteq A \times T$ – a relation that connects attributes and data types from which they can take their values, $R_{AD} \subseteq A \times D$ – a relation that defines for each attribute its discrete set of values (domain); F – a Set of restrictions on the values of attributes of concepts and relationships.

From a meaningful point of view, the ontology defined in this way can serve to represent the concepts necessary for describing a particular field of knowledge, as well as for the scientific activities performed within it. This ontology was chosen as the information model of the scientific knowledge portal. By introducing formal descriptions of domain concepts in the form of object classes and relationships between them, the portal ontology sets structures for representing real data and relationships between them. The data itself is presented on the portal as a set of related information objects.

Each information object (IO) corresponds to a certain ontology class (it is an instance of it) and represents a description of some object in the domain. There may be connections between information objects whose semantics are determined by the relationships defined between the corresponding ontology classes. The portal content is provided using an ontology-driven data editor that allows you to create, edit, and delete information objects and relationships between them. Forms for entering specific IO and their associations are automatically generated based on the portal's ontology. Thus, the information content of the portal includes both General knowledge (presented in the ontology) and knowledge about specific objects and relations between them (represented by information objects and their connections). For meaningful access to this content, the knowledge portal provides advanced navigation and search tools.

Navigation through the portal content is performed in accordance with the content of the ontology: it provides a transition from ontology classes to their instances, and then a transition through ontological relationships from a specific instance to lists of related instances, and so on.

Information search is also based on ontology, which allows the user to set a query in terms of the portal's subject area. For example, when selecting a class of information objects to search for, a search form is automatically generated, in which the user can set restrictions on the attribute values of objects of the selected class, as well as on the attribute values of objects associated with this object by associative relations. For example, the query "Find recommended literature by the type article in a course from 1920 to 1990" will formally look like this:

Class «Course »:
Relation «recommended literature»:
Class «Publication»
attribute «Type» = «article»
Attribute «Start date»: (>= 1920) & (<=1990)
Attribute «End data»: (>= 1920) & (<=1990)

Technology for building the knowledge portal ontology. The portal's ontology construction technology includes a language for describing ontologies, a methodology for building and developing ontologies, and an ontology editor. The ontology description language and the ontology editor were selected and designed in such a way that they were understandable to experts who are not specialists in computer science and knowledge representation, and they were easy and convenient to use. In addition, the ontology editor was built with its application for distributed ontology development in mind.

On the one hand, the methodology for building an ontology for the knowledge portal is almost completely determined by its structure, and on the other hand, it is supported and at the same time limited by the tools provided by the ontology editor. In the process of ontology development, classes of concepts and their properties are distinguished and formally described. The properties of each concept are represented using attributes and restrictions imposed on the scope of their values, as well as binary relations that link this concept to other concepts. Concept classes are arranged in a hierarchy using the inheritance relation ("General–private"). The inheritance mechanism is set in such a way that not only all its attributes, but also relations are passed to the descendant concept from the parent concept.

Structure of the knowledge portal ontology. In order for the ontology to meet the goals of the portal, it must be well structured and adequately reflect its problem and subject area. As the base ontology were selected as two of the ontology. The first of them describes the problem area of the system (Fig. 1). It does not depend on the subject area of the system and is a top-level ontology that includes classes of concepts related to the organization of educational activities, such as *Person, Organization, Scientific activity, Scientific events, Publication, Geographical location, Collection of conference* materials used to describe its participants, organization of educational work, events (seminars, conferences), joint projects, various types of information resources.

The second ontology is the ontology of subject knowledge. it sets meta-concepts for describing the concepts of possible subject areas, defining structures for describing the concepts of a specific field of knowledge, such as the *Training course, Competence, The task of the training course, Methods for solving problems and the Result of mastering the course*. The concepts of the base ontology are linked associative relations, which was carried out not only on the basis of the completeness problem and subject areas of the system, but also taking into account ease of navigation, educational content, and information retrieval. The ontology constructed in this way not only describes the subject and problem area of the system, but also sets structures for representing real objects (including information resources) and connections between them. The semantics of relations between information objects is determined by the relations defined between the corresponding ontology concepts. The totality of such information objects and their connections forms the information content or content of the system.

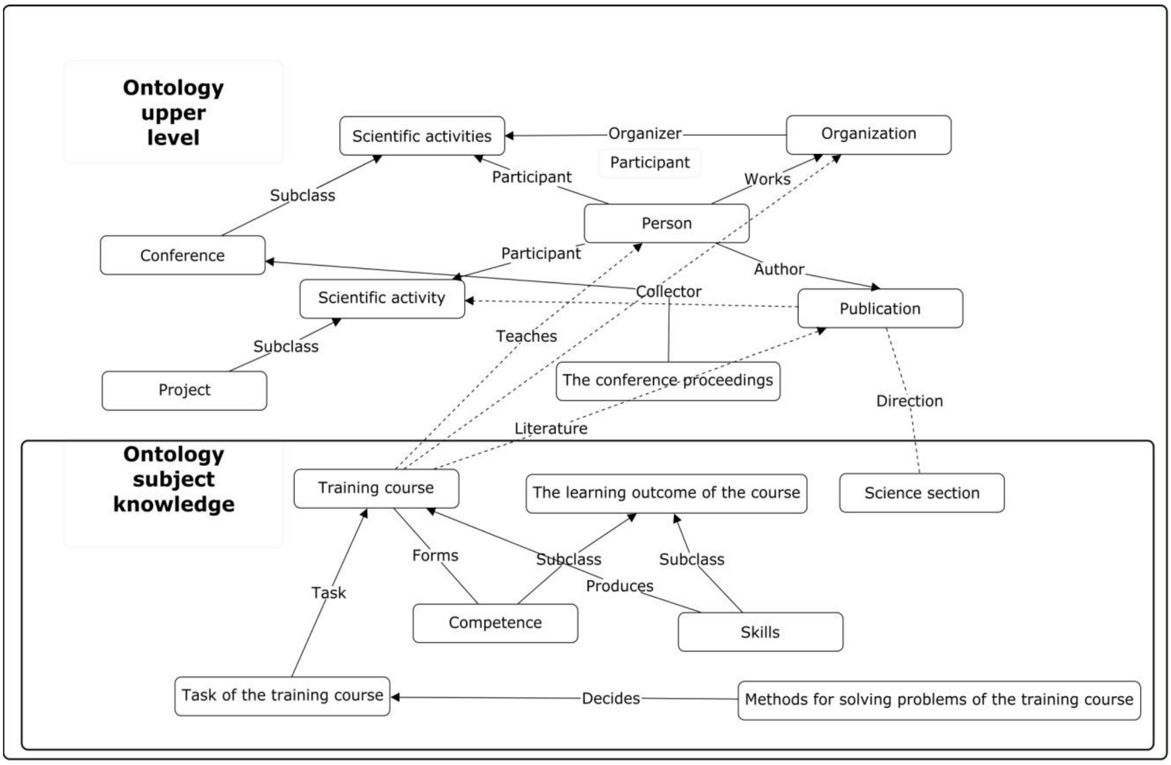

Figure 1. Basic ontologies of the knowledge portal

Methods of ontology development. During the operation of the knowledge portal, new knowledge about its subject area may appear, and gaps and inaccuracies in the knowledge already presented in the ontology may be detected. All this, of course, requires a change in the ontology. However, when editing the ontology, you must make sure that the logical integrity of the portal's knowledge system is not violated and information is not lost.

A change in an ontology can consist of expanding or rebuilding its concept system, deleting or renaming concepts and / or relationships. First, let's consider the cases related to the extension of the ontology concept system.

In the simplest case, this extension consists of adding a new attribute to a concept. Here you need to take into account that concepts that are descendants of this concept may already have this attribute. Therefore, you need to view all such descendants and, if necessary, rename the corresponding attributes. Adding a new concept to the very bottom of the concept hierarchy does not require any effort to maintain the integrity of the concept system, since the new concept inherits all the attributes and relationships of the higher concepts. If you add a concept that becomes the root of one of the concept hierarchies, you must consider the attributes and relationships of the lower concepts. It may be necessary to move some of the attributes and relationships to the new concept, especially given the prospect of new branches of the hierarchy originating from the new concept.

Inserting a new concept into the hierarchy between two " old " concepts also requires some methodological effort. To avoid duplication and possible name collisions, you must carefully select attributes and relationships for it from the lower-level concepts.

When deleting a "leaf" concept, i.e. a concept at the very bottom of the hierarchy, you should think about transferring its own attributes and relationships to a higher concept, so that there is no loss of knowledge. Keep in mind that if information objects have already been created based on the concept being deleted, then in order not to lose data, these information objects must be linked to the ancestor of the concept being deleted. However, this may not be enough to save all the information about these objects if all the proper attributes and associations of the deleted concept are not passed to the parent concept first.

If the concept being deleted is not a "leaf" concept, then before deleting it, you should think about passing its attributes and relationships to a lower-level concept. Information objects, as in the case of a "leaf concept", must be linked to a higher-level concept and modified in accordance with its structure.

Removing the "root" concepts of the ontology of a portal that is in operation or at the stage of information content is not recommended because of possible loss of information.

When deleting attributes from concepts, you should also consider possible loss of information. A special case of deleting an attribute is moving it to a higher or lower level concept, when it turns out that this attribute is more General or, conversely, more specific. In the first case, there is no loss of information, since the attribute being moved will still be inherited by the concept being modified. In the second case, such a loss is possible, and measures should be taken to restore it.

Sometimes you have to move a concept inside the hierarchy. However, keep in mind that not only the set of attributes inherited by the concept changes, but also the relationships. It is possible that some attributes and relationships lost as a result of this move will have to be restored "manually".

Moving subtrees from one branch of the hierarchy to another is quite interesting. This case is almost recursively reduced to the one discussed above. In most cases, it is sufficient to "put in order" the root concept of the moved subtree, and the other concepts are modified automatically.

Language for describing ontologies. The well-established Semp-TAO knowledge representation language was used as the basis for the ontology description language [7].

Concept classes in this language are described as follows:

class Classname (ParentClass);
DescriptionOfAttributes;
constraints
DescriptionOfRestrictions;
end;

Here is an example of a simplified description of the "Person" class»:

class Person;
Surname: string;
Name: string;
Gender: Gender:;
Date of birth: date;
Date of death: date;

constraints

Birthdate < Deathdate;

end;

The following mathematical properties can be attributed to relations: *transitivity, symmetry, and reflexivity.*

Here is an example of a description of the «Works in»:

relation Works_in (who: Person; where: Organization);

Position: Position;

Date_of acceptance: date;

Date_of termination: date;

constraints

Date_of acceptance > date_of birth +18;

Date_of dismissal > date _of acceptance;

end;

Domains are described as follows:

Domain domain_name = Set_OfStringValues;

Here are examples of descriptions of some domains:

Domain Gender = {male, female};

Domain Position = {Director, Scientific Secretary, head of laboratory, head of Department, Chief scientist, Lead researcher, Senior researcher, Research assistant, Junior researcher, Technician}.

The ontology editor was built on the basis of the ontology description language given above . It was built with the possibility of using it for distributed ontology development and is implemented as a web application available to registered users via the Internet. In order to ensure distributed ontology development, the editor supports a mechanism for delegating rights to experts at different levels.

You can use the ontology editor to create, modify, and delete any ontology elements: concept classes, relationships, and domains.

When creating a class, you specify its unique name and a set of attributes that are used to set various properties of concepts, and actually describe the structure of objects in this class. A parent can be selected for a class from previously created classes, and not only all attributes, but also relationships are inherited from the parent class, and the parent itself is associated with the new class by the "class-subclass"relationship. For each attribute of the class, enter a name, the scope of acceptable values (type or domain), the number of possible values (one or many), and specify whether they must be filled in.

A domain is characterized by a name and a set of elementary values. For each domain value, you can also specify the language (currently Russian, Kazakh, or English) in which it was entered.

Relationships can link only to have the generated classes of the ontology. They are directed and binary, and can have their own attributes that specify the relationship between the relationship arguments. For a more convenient presentation of information, the portal user can configure the visualization of knowledge and data. For each class, the ontology editor sets a template for visualizing objects of this class and a template for visualizing links to them. By default, the order in which class attributes and related relationships are displayed, including relationship attributes, is determined by the order in which they are set in the ontology. This order can be changed at the user's request.

Conclusion. The article presents a technology for building ontologies for scientific knowledge portals, including a methodology for building ontologies and an ergonomic editor. This technology supports the development of ontologies that automatically build:

- schema of the portal's internal database (the logical structure of the database and its integrity restrictions);

- forms for filling in the portal database with data (information objects that are instances of ontology concepts);

– navigation scheme for the portal's information space (on ontology relations);

– forms of search terms (concepts and relations of the ontology).

This technology allows declarative adjustment of the ontology during the operation of the knowledge portal, which allows you to track the dynamics of the emergence of new knowledge and information resources on the subject of the portal and thus provides support for its relevance and usefulness.

This research has been/was/is funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP08857179).

References

1. Sadirmekova Zh.B., Zhizhimov O.L., Tussupov D.A., Sambetbayeva M.A. Requirements for information system to support scientific and educational activities // CEUR Workshop Proceedings (DICR-2019), Novosibirsk, 2019. P. 44-47.

2. Ushold M., Gruninger M. Ontologies: Principles, Methods and Applications, Knowledge Engineering Review, 11(2), 93–155 (1996).

3. Fedotov A.M., Tusupov J.A., Sambetbayeva M.A., Fedotova O.A., Sagnayeva S.K., Bapanov A.A., Tazhibaeva S.Z. Classification model and morphological analysis in multilingual scientific and educational information systems, Journal of Theoretical and Applied Information Technology, 1, 96-111 (2016).

4. Fedotov A.M., Tusupov J.A., Sambetbayeva M.A., Sagnayeva S.K., Bapanov A.A., Nurgulzhanova A.N., Yerimbetova A.S. Using the thesaurus to develop it inquiry systems, Journal of Theoretical and Applied Information Technology, 1, 44-61(2016).

5. Gruber T. Towards Principles for the Design of Ontologies Used for Knowledge Sharing, International Journal of Human and Computer Studies, 43, 907–928 (1995).

6. Sadirmekova Zh.B, Tussupov D.A., Sambetbayeva M.A., Nurgulzhanova A.N., Doshtaev K.Zh. Development of the Methodology for Metadata Extraction from Documents in the Course of Information System Integration Using the Ontological Model of the Subject Field, International Journal of Emerging Trends in Engineering Research, Vol. 8(9), 6231–6239 (2020).

7. Sadirmekova Zh.B., Tussupov D.A., Sambetbayeva M.A., Daiyrbayeva E.N. Development of an information system model designed to support scientific and educational activities, The Bulletin of Kazakh Academy of Transport and Communications named after M.Tynyshpayev, 3, 276–284 (2020).

Ж.Б. Садирмекова[1], Д.А. Тусупов [1], М.А. Самбетбаева [1,2],
Ж.Т. Алтынбекова[3]

[1] Л.Н.Гумилев атындағы Еуразия ұлттық университеті, Нұр-Сұлтан, Қазақстан
[2]Ақпараттық және есептеуіш технологиялар институты, Алматы, Қазақстан
[3]Тараз инновациялык – гуманитарлық университеті, Тараз, Қазақстан

Ғылыми-білім беру қызметін қолдаудың ақпараттық жүйесіне онтологияларды құру технологиясы

Аңдатпа. *Мақалада онтология негізінде ғылыми порталдарды ұйымдастыру тәсілі ұсынылған. Онтология Интернет-Білім порталының ақпараттық негізін құрайды, ол белгілі бір тақырыптағы ғылыми білімдер мен ақпараттық ресурстарды біріктіруді және жүйелеуді, сондай-ақ, Интернет-кеңістіктің кез келген "нүктесінен" оларға мазмұнды қолжетімділікті қамтамасыз етуі тиіс. Онтология бойынша порталдың ішкі деректер базасының схемасы және оны толтыруға арналған нысандар автоматты түрде құрылады, порталдың ақпараттық кеңістігі бойынша навигация ұйымдастырылады және білім порталының пәндік саласы терминдерінде іздеу сұраныстарын* *қалыптастыру қамтамасыз етіледі. Порталдың онтологиясын тәуелсіз және пәндік онтологияға бөлу порталды ғылыми білімнің кез келген саласына теңшелетін болады. Бұл технология білім порталының жұмыс істеу процесінде онтологияны декларативті түзетуге мүмкіндік береді, бұл портал тақырыбы бойынша жаңа білім мен ақпараттық ресурстардың пайда болу динамикасын бақылауға мүмкіндік береді және сол арқылы оның өзектілігі мен пайдалылығын қолдауды қамтамасыз етеді.*

***Түйін сөздер**: онтология, білім порталы, интеграция, ақпараттық жүйе, ақпараттық модель.*

Ж.Б. Садирмекова[1], Д.А. Тусупов [1], М.А. Самбетбаева [1,2], Ж.Т. Алтынбекова[3]

[1]Евразийский национальный университет им. Л.Н.Гумилева, факультет информационных технологий, Нур-Султан, Казахстан

[2]Институт информационных и вычислительных технологий КН МОН РК, Алматы, Казахстан

[3]Таразский инновационно-гуманитарный университет, Тараз, Казахстан

Технология построения онтологий для информационной системы поддержки научно-образовательной деятельности

***Аннотация.** В статье представлен подход к организации научных порталов на основе онтологий. Онтология - это информационная основа Интернет-портала знаний, которая должна обеспечивать интеграцию и систематизацию научных знаний и информационных ресурсов определенного субъекта, а также содержательный доступ к ним из любой "точки" интернет-пространства. Онтология автоматически строит схему внутренней базы данных портала и формы ее заполнения, организует навигацию по информационному пространству портала и обеспечивает формулировку поисковых запросов в терминах предметной области портала знаний. Разделение онтологии портала на предметно-независимые и предметно-специфические онтологии делает портал настраиваемым практически для любой области научного знания. Данная технология позволяет осуществлять декларативную корректировку онтологии в процессе функционирования портала знаний, что позволяет отслеживать динамику появления новых знаний и информационных ресурсов по тематике портала и тем самым обеспечивает поддержку его актуальности и полезности.*

***Ключевые слова**: онтология,* портал знаний, интеграция, информационная система, информационный модель.

Список литературы

1. Sadirmekova Zh.B., Zhizhimov O.L., Tussupov D.A., Sambetbayeva M.A. Requirements for information system to support scientific and educational activities CEUR Workshop Proceedings (DICR-2019). Novosibirsk, 2019. P. 44-47.
2. Ushold M., Gruninger M. Ontologies: Principles, Methods and Applications, Knowledge Engineering Review, 1996. Vol. 11 (2). P. 93–155.
3. Fedotov A.M., Tusupov J.A., Sambetbayeva M.A., Fedotova O.A., Sagnayeva S.K., Bapanov A.A., Tazhibaeva S.Z. Classification model and morphological analysis in multilingual scientific and educational information systems, Journal of Theoretical and Applied Information Technology. 2016. Vol.86. № 1. P. 96-111.
4. Fedotov A.M., Tusupov J.A., Sambetbayeva M.A., Sagnayeva S.K., Bapanov A.A., Nurgulzhanova A.N., Yerimbetova A.S. Using the thesaurus to develop it inquiry systems, Journal of Theoretical and Applied Information Technology. 2016. Vol.86. № 1. P.44-61.
5. Gruber T. Towards Principles for the Design of Ontologies Used for Knowledge Sharing Int. J. of Human and Computer Studies. 1995. Vol. 43. № 5/6. P. 907–928.

6. Sadirmekova Zh.B, Tussupov D.A., Sambetbayeva M.A., Nurgulzhanova A.N., Doshtaev K.Zh. Development of the Methodology for Metadata Extraction from Documents in the Course of Information System Integration Using the Ontological Model of the Subject Field, International Journal of Emerging Trends in Engineering Research. 2020. Vol. 8(9). P. 6231–6239.

7. Sadirmekova Zh.B., Tussupov D.A., Sambetbayeva M.A., Daiyrbayeva E.N. Development of an information system model designed to support scientific and educational activities. The Bulletin of Kazakh Academy of Transport and Communications named after M.Tynyshpayev. 2020. Т.3. №3. P.276–284.

Information about authors:

Садирмекова Ж.Б.- автор для корреспонденции, Л.Н. Гумилев атындағы Еуразия ұлттық университеті 6D070300- «Ақпараттық жүйелер» мамандығының докторанты, Нұр-Сұлтан, Қазақстан.

Тусупов Д.А.- Л.Н. Гумилев атындағы Еуразия ұлттық университеті «Ақпараттық жүйелер» кафедрасының меңгерушісі, физика-математика ғылымдарының докторы, Нұр-Сұлтан, Қазақстан.

Самбетбаева М.А.- PhD, Л.Н. Гумилев атындағы Еуразия ұлттық университеті «Ақпараттық жүйелер» кафедрасының доценті, Нұр-Сұлтан, Қазақстан.

Алтынбекова Ж.Т. - Тараз инновациялык-гуманитарлық университеті «Ақпаратты-коммуникативтік технологиялар» кафедрасының аға оқытушысы, Тараз, Қазақстан.

Sadirmekova Zh.B. – author of corresponding, Ph.D. student in Information system, L.N. Gumilyov Eurasian National University, Nur-Sultan, Kazakhstan.

Tussupov J.A. - Head of the Department of Information Systems, L.N. Gumilyov Eurasian National University, Doctor of Physical and Mathematical Sciences, Nur-Sultan, Kazakhstan.

Sambetbayeva M.A. - Ph.D., Associate Professor, Nur-Sultan, Kazakhstan, Department of Information Systems, L.N. Gumilyov Eurasian National University. Senior Researcher, Institute of Information and Computing Technologies, Almaty, Kazakhstan.

Altynbekova Zh.T. - Senior Lecturer of Information and communication technologies Department of Taraz Innovative Humanitarian University, Taraz, Kazakhstan.