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IMPLEMENTATION OF THE APPROACH TO ONTOLOGICAL MODELING OF THE MUSICAL SUPERGENRE “METAL”

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Background. The relevance of the article is due to the development of modern ontological methods of structuring information and the need to systematize data in many new specific subject areas. Such subject areas include the musical art of the "metal" variety, which is quite common today, but insufficiently studied within the terminology. The subject of the article are ontological models and tools for creating ontological knowledge bases.

Objective. The purpose of the paper is to increase the correctness of the semantic search in the knowledge base of the musical supergenre "metal". The scientific problem is the need to improve the terminology in this subject area and build an ontological knowledge model that increases the accuracy of information retrieval for the target audience, compared to the existing relational model implemented on one of the known web resources.

Methods. Classification method, generalization method, software optimization methods, analytical method. The way to solve the problem: selection based on the comparative characteristics of the best web resource of the subject area and identifying the shortcomings of its model of knowledge representation, designing an ontological knowledge model and testing its effectiveness.

Results. The average SUM for all users is 83.85%, which is a good indicator for ontological knowledge bases. At the same time, a similar method of checking the database of the supergenre "metal" on the basis of the site "Encyclopedia Metallum", which used the classical relational model of database organization, showed much lower results. Thus, the average SUM for 10 users was 75.32%, respectively.

Conclusions. The scientific novelty of the obtained results is as follows: For the first time an ontological model (ontology) of the subject area was created: musical supergenre "metal", which showed much higher efficiency of semantic search than the best relational model of this subject area, implemented as a web resource. The developed structure can be used to create ontologies of related musical supergenres with similar terminology. Future research also plans to integrate this ontological knowledge model with applied web-based and desktop applications.

Keywords: ontological model; knowledge base; metal; genre; Protégé; semantics.

Introduction

Today, the substantial humanity's challenge is the significant growth of daily information. Therefore, experts are no longer faced with the question of separating important information from the supposedly secondary one, but the problem of formalization, conceptualization and classification of individual subject areas. The task is complicated by the emergence of new, specific areas, especially those related to science and culture. Ontological knowledge bases are ideal for the development of such a high-quality terminology system, as well as its modelling and implementation in the modern information environment. After all, they are more effective than traditional models of knowledge representation on the criteria of quality of graphic representation, data structuring and the possibility of advanced information retrieval by means of query creation. This approach is especially justified for the latest insufficiently researched subject areas, knowledge of which should be properly systematized. On the example of such a specific newest subject area, namely the subject area of the musical supergenre "metal", it was decided to conduct a study of the method of ontological design to obtain specific knowledge.

1. Relevance of the research

A. Establishing the relevance of the study

The relevance of the study can be proved from two sides: from the growing interest of the scientific

community to ontological knowledge bases and the study of their capabilities in general and from the chosen subject area of the musical supergenre "metal", which brought together many fans around the world and became a kind of cultural phenomenon of the XX and XXI centuries.

B. Review of analogues in terms of ontological knowledge bases

It is extremely important to review the latest literature on the creation of ontologies.

A significant problem in the development of ontologies is the presentation of knowledge graphs in a user-friendly form with the ability to integrate them into the interface of a particular API. It is proposed to solve this challenge by means of setting a number of restrictions and specifications, as well as by high-level SPARQL-queries. These queries are proposed to be integrated with modern web-oriented programming languages such as JavaScript [1].

Protégé, as one of the most powerful tools for developing ontologies, has its own limitations. Such limitations often give rise to a debate as to whether Protégé can meet the needs of a wide variety of developers for different research or design purposes. Therefore, one of the scientific studies compared the work with this tool on a standard tutorial, in a research laboratory and during development for practical purposes [2]. It was found that despite the slight differences in patterns and approaches to work, it is possible to develop a general set of recommendations that avoids significant problems in the end use.

A controversial issue in the development of ontologies of different levels is the classification of

entities in domain ontologies under the upper classes of ontology [3]. Integrating top ontologies in this way is difficult and, despite new automated methods, remains largely a manual task. During the mass collective expertise conducted by the authors of this study, an important conclusion was made about the improvement of the methodological base around the manual integration of domain and top ontologies.

The advantages and disadvantages of all the above ontological knowledge bases are shown in Table 1.

Table 1 – Comparative analysis of ontologies

Ontology (discussed above)	Advantages	Disadvantages
I	Integration with JavaScript, friendly graphical presentation interface.	Non-universality of the approach.
II	Universalization of approaches to work with ontologies on the example of different development goals.	The sample of experiments is too small, which can lead to doubts about the validity of the conclusions.
III	The possibility of creating a universal terminology system for related subject areas by certain features is shown.	No attention is paid to subject areas, which are difficult to allocate a place in the modern classification.

C. Review of analogues in terms of knowledge bases of the supergenre "metal"

The goal of the research is to increase the correctness of the semantic search in the knowledge base of the musical supergenre «metal». Relevance of the research caused sufficient prevalence of kind of music named «metal», that has both many genres and a basis for philosophical currents of modernity that found many fans throughout the world. Nowadays, we can identify several well-known resources, covering not only the events or news of the metal underground, but also describing the existing rigid classification of certain objects in this subject area. This is an important indicator for the metal community as a counterculture that has existed for half a century and keeps increasingly expanding its horizons through the rapid development of new, more modern subgenres and integration with many other philosophical currents and cultural phenomena.

Encyclopaedia Metallum [4] – this resource systematizes different genres of metal, groups, artists, albums and their varieties, record labels. The site has detailed information even about beginner bands, it is also possible to track the rating of the band by written reviews. Available information about band members. The site has information retrieval functions based on relational cross and multi-parameter queries.

DARK ALBUM [5] offers the ability to search for interesting information on the parameters of the genre, country and year of foundation, also on the site there are reviews and lyrics of famous tracks, subculture news.

Altwall [6] is a resource focused on news and concerts, but it also has a metal genealogy tree. The site positions itself as a researcher of contemporary music, so

there are other, smaller, supergenres.

Analysing the above software products, we can identify a number of disadvantages and advantages for each of them. The comparative characteristics are given in Table 2.

Table 2 – Online resources' comparative analysis of the musical supergenre “metal”

Resource	Advantages	Disadvantages
Encyclopaedia Metallum	The possibility of advanced search, rather high accuracy of classification at the expense of what convenience of search is reached.	Lack of some information about certain bands, some bands can be removed by the moderator due to the contradiction of their belonging to the supergenre "metal".
DARK ALBUM	A large amount of illustrative material, there are explanations for non-target audience.	Too simple and inconvenient search, low level of systematization of information.
Altwall	Dynamic content, modern design, conciseness and clarity of information.	Significant errors in classification, illogicality of some connections in the knowledge base.

2. Implementation of the musical supergenre “metal” ontological model

A. Initialization of the Terminological System of the Supergenre “Metal”

The subject area of the musical supergenre "metal" is very voluminous both in terms of the dynamics of changes in information and in terms of the general structure of basic concepts. The key basic concepts of the subject area from which to start are the concepts of "genre" and "band". Further, the terminology expands and takes into account a large number of concepts, the main of which are: "country of origin", "status", "year of foundation", "years of activity", "lyrical themes", "label" and others.

After identifying key concepts, it is advisable to build a hierarchy of the subject area, at the root of which will be the terminology, and at the nodes – the nomenclature.

The semantic network of frame signs is used as a model of nomenclature knowledge representation. The S semantic network is constructed as a combination of frame characters Φ_i : $S = \cup_i \Phi_i$.

It can be assumed that in general a set of terms. This means that the power of the set $\Phi = \{\Phi_i\}$ is greater than the power of the set Term. A graphical representation of a fragment of the semantic network S for constructing an ontology of metal music can be seen in Fig. 1. It should be noted that the created graph is basic, so it can be modified and expanded if necessary, and the main purpose of its creation is the need for graphical implementation of the terminology.

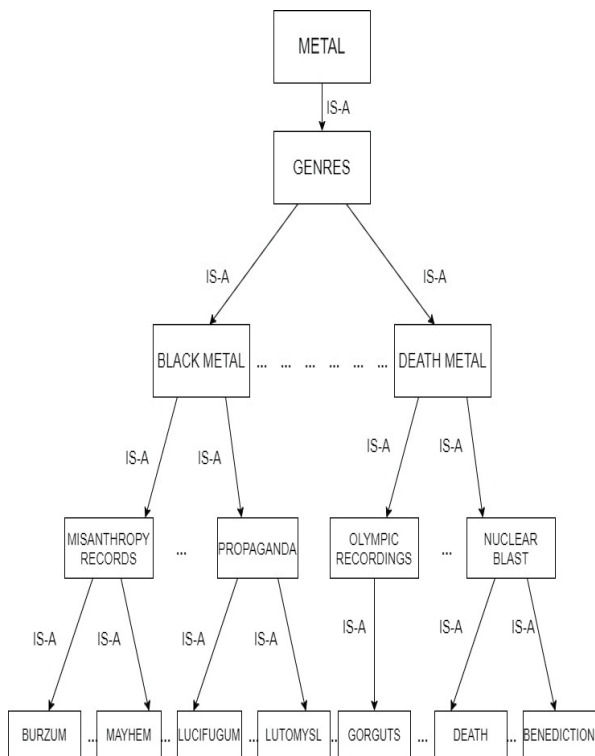


Fig. 1. A fragment of the semantic network for building an ontology of the musical supergenre «metal»

B. Ontology Coding

Ontology coding involves first of all the definition of tools, so the development environment for creating a powerful knowledge base. To do this, it is necessary to compare several modern tools for designing ontological knowledge bases and determine the most effective for this development. The comparative characteristics are given in Table 3.

Table 3 – Comparative analysis of ontology tools

Ontology tool	Advantages	Disadvantages
Ontolingua	The presence of a large archive of ontologies, which allows them to be corrected and created using existing ones, the ability to import and graphical modelling.	Obsolete client-server architecture
Protégé	Convenience of converting the hierarchy of the subject area into program code, high quality visualization, the presence of a number of plugins, constant improvement and free access.	Practically absent.
OntoEdit	The convenience of use, development of an ontology under the guidance of a methodology and through an inference process, development of axioms, extensible structure through plugins.	Closed source code.

Thus, Protégé is the most convenient and powerful tool for designing the ontology of the musical supergenre "metal" due to open source code and high-quality visualization.

The following are the main stages of ontology coding.

1. Selection of classes and subclasses, establishing a clear hierarchy between them.
2. Establishing relations of symmetry, equivalence, transitivity, reflexivity, etc. where necessary.
3. Set data types or create new ones as needed.
4. Establishing the possibility or impossibility of crossing certain classes.
5. Constructing expressions and organizing information.
6. Granting properties to individuals.
7. Implementation of a quick search for information by means of SPARQL.

An important result of the work is the basic graph of the ontology built automatically by the environment, which will be further expanded.

This graph is shown in Fig. 2.

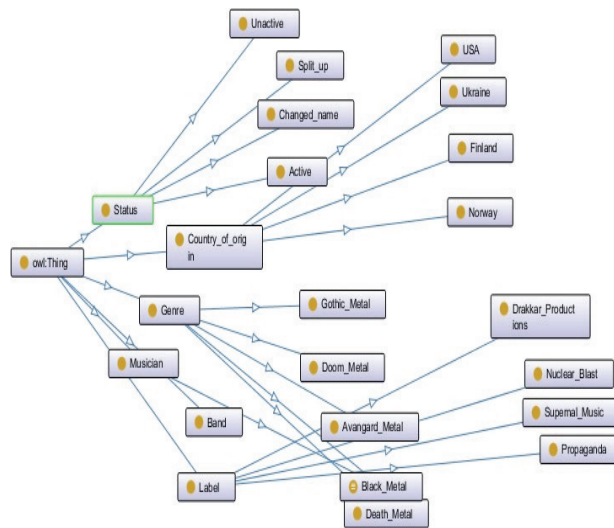


Fig.2. Basic graph of the ontology of the supergenre "metal"

3. Information search efficiency testing

Gomez-Perez proposed the following definition of ontology assessment in the context of knowledge sharing technologies: "to compile a technical opinion on ontology, its associated software environment and documentation, on criteria ... the world "[7].

Among modern metrics, there are not many that take into account all the criteria, so it was decided to use the metric Single Usability Metrics (SUM),

developed by analyst Jeff Soro [8].

This metric is determined by the formula in the context of ontology development, the Completion indicator is a Boolean value and indicates the achievement of the goal of obtaining information by the user, Satisfaction shows the level of satisfaction with structuring information in this ontology, Errors shows the occurrence of certain inconsistencies or other errors in obtaining information and Times shows the average number of requests.

To determine the correctness of the search for information in the implemented ontological knowledge base, it was provided to 10 users, each of whom implemented 10 queries on it.

The average SUM metric for all users will be 83.85%, which is quite a good indicator for ontological knowledge bases. At the same time, a similar method of testing the database of the supergenre "metal" of the site "Encyclopaedia Metallum", which used the classical relational model of database organization, showed much lower results. Thus, the average SUM metric for 10 users was 75.32%, respectively.

Fig. 3 illustrates the graph of the average scores of ten experts on SUM metrics according to two models of the knowledge base of the music supergenre "metal" – a relational base, implemented on the most famous web resource in this subject area called "Encyclopaedia Metallum", and ontological model created in this research. The graph clearly shows that despite some differences due to individual experiments of experts, the developed ontological model is ahead of relational in search efficiency, and in some cases the user found the necessary information with 100% efficiency.

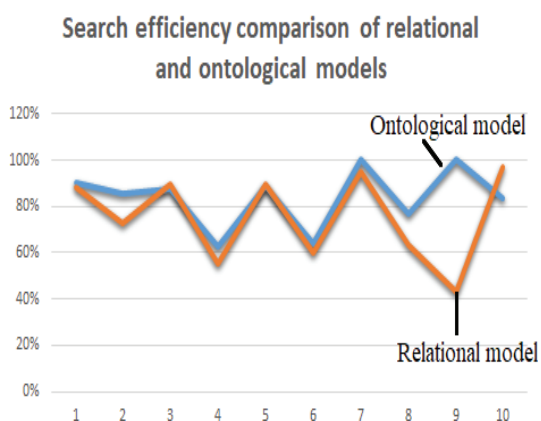


Fig.3. Search efficiency comparison of relational and ontological models

Conclusions

1. The study proposes a new ontological model of knowledge base (ontology) of the subject area: musical supergenre "metal".
2. By means of the Protégé, the ontology of the subject area of the musical supergenre "metal" is realized in the form of a knowledge base.
3. Testing of the implemented knowledge

base and evaluation of the correctness of the semantic search according to the SUM metric was conducted.

4. The purpose of the study – to increase the correctness of the semantic search of information is achieved through the use in the implementation of the knowledge base of a new ontological model (ontology) of the musical supergenre «metal». In comparison with the classical, relational model of the organization in databases application of new ontology allows to raise correctness of search by 8%.

5. It is revealed that by means of Protege, it is possible to design various bases of knowledge even of informal subject areas. However, it allows you to create your own data types, create new relationships, make a quality formalization of information – in other words, there are ample opportunities to expand functionality.

6. The scientific problem is the need to improve the terminology in this subject area and build an ontological knowledge model that increases the accuracy of information retrieval for the target audience, compared to the existing relational model implemented on one of the known web resources.

7. The following methods were used: classification method, generalization method, software optimization methods, analytical method.

8. The way to solve the problem: selection based on the comparative characteristics of the best web resource of the subject area and identifying the shortcomings of its model of knowledge representation, designing an ontological knowledge model and testing its effectiveness.

9. The developed structure can be used when creating ontologies of related musical supergenres with similar terminology.

10. Future research also plans to integrate this ontological knowledge model with applied web-based and desktop applications.

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Реалізація підходу до онтологічного моделювання музичного наджанру «метал»

Проблематика. Актуальність статті обумовлена розвитком сучасних онтологічних методів структурування інформації та необхідністю систематизації даних у багатьох нових конкретних предметних галузях. До таких предметних областей можна віднести музичне мистецтво течії «метал», яке сьогодні є досить поширеним, але недостатньо вивченим в рамках термінології. Предметом статті є онтологічні моделі та інструменти для створення онтологічних баз знань.

Мета дослідження. Мета - підвищити коректність смислового пошуку у базі знань музичного наджанру «метал». Наукова проблема полягає в необхідності покращення термінології у цій предметній галузі та побудови онтологічної моделі знань, що підвищує точність пошуку інформації для цільової аудиторії, порівняно з існуючою реляційною моделлю, реалізованою на одному з відомих веб-ресурсів.

Метод реалізації. Метод класифікації, метод узагальнення, методи оптимізації програмного забезпечення, аналітичний метод. Спосіб вирішення проблеми: вибір на основі порівняльної характеристики кращого веб-ресурсу предметної галузі та виявлення недоліків його моделі представлення знань, побудова онтологічної моделі знань та перевірка її ефективності.

Результати дослідження. Середнє значення SUM для всіх користувачів становить 83,85%, що є гарним показником для онтологічних баз знань. У той же час аналогічний метод перевірки бази даних наджанру "метал" на базі сайту "Енциклопедія Металум", який використовував класичну реляційну модель організації бази даних, показав набагато нижчі результати. Таким чином, середній SUM для 10 користувачів становив 75,32%.

Висновки. Наукова новизна одержаних результатів полягає в наступному: Вперше створено онтологічну модель (онтологію) предметної області: музичний наджанр «метал», який показав набагато більш високу ефективність семантичного пошуку, ніж краща реляційна модель предметної області, реалізована як веб-ресурс. Розроблена структура може бути використана для створення онтологій родинних музичних наджанрів зі схожою термінологією. У майбутніх дослідженнях також планується інтегрувати цю онтологічну модель знань із прикладними веб-додатками та настільними додатками.

Ключові слова: онтологічна модель; база знань; метал; жанр; Protégé; семантика.

Зелинская Д.О., Гирдвайнис В.А., Силагин О.В.

Реализация подхода к онтологическому моделированию музыкального наджанра «метал»

Проблематика. Актуальность статьи обусловлена развитием современных онтологических методов структурирования информации и необходимостью систематизации данных во многих новых конкретных предметных областях. К таким предметным областям можно отнести музыкальное искусство течения «метал», которое сегодня довольно распространено, но недостаточно изучено в рамках терминологии. Предметом статьи являются онтологические модели и инструменты для создания онтологических баз знаний.

Цель исследования. Цель - повысить корректность смыслового поиска в базе знаний музыкального наджанра «метал». Научная проблема заключается в необходимости улучшения терминологии в этой предметной области и построения онтологической модели знаний, повышающей точность поиска информации для целевой аудитории, по сравнению с существующей реляционной моделью, реализованной на одном из известных веб-ресурсов.

Метод реализации. Метод классификации, метод обобщения, методы оптимизации программного обеспечения, аналитический метод. Способ решения проблемы: выбор на основе сравнительной характеристики лучшего веб-ресурса предметной области и выявление недостатков его модели представления знаний, построение онтологической модели знаний и проверка ее эффективности.

Результаты исследования. Среднее значение SUM для всех пользователей составляет 83,85%, что является хорошим показателем для онтологических баз знаний. В то же время аналогичный метод проверки базы данных наджанра «метал» на базе сайта «Энциклопедия Металлум», который использовал классическую реляционную модель организации базы данных, показал гораздо более низкие результаты. Таким образом, средний SUM для 10 пользователей составил 75,32%.

Выводы. Научная новизна полученных результатов заключается в следующем: Впервые создана онтологическая модель (онтология) предметной области: музыкальный наджанр «метал», показавший гораздо более высокую эффективность семантического поиска, чем лучшая реляционная модель предметной области, реализованная как веб-ресурс. Разработанная структура может быть использована для создания онтологий родственных музыкальных наджанров со схожей терминологией. В будущих исследованиях также планируется интегрировать эту онтологическую модель знаний с прикладными веб-приложениями и настольными приложениями.

Ключевые слова: онтологическая модель; база знаний; метал; жанр; Protégé; семантика.