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Articles

Semasiological Modeling in Real Estate Management

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Abstract

The article examines the technologies of real estate management of public educational organizations. A new control technology is considered. which the author calls semasiological. The term "semasiological" is borrowed from the field of linguistics. It characterizes the interdisciplinary transfer of knowledge. Semasiological control technology is based on semasiological modeling. In this technology, management models are built according to the bottom-up principle. Semasiological modeling is implemented through the use of information units as elementary models. Complex management models are formed from elementary models. Related types of modeling are described: onomasiological modeling and semasiological modeling. The difference between these types of modeling is shown. Information units are used in the modeling type. The article provides an analysis of the types of information units. The article provides an analysis of the types of modeling that is used in real estate management. The main components of semasiological technology of real estate management are described. The article shows the need to use information units as the basis of semasiological modeling and semasiological control. The importance of corporate real estate management in sectoral management is shown.

Keywords: computer scientist, modeling, information models, information units, onomasiological modeling.

1. Introduction

Real estate management of state educational organizations is a management complex that uses the general theory of management, taking into account the characteristics of state educational organizations. State educational organizations belong to the social sphere. They require government support and are economically unprofitable on a micro scale. State educational organizations cannot be equated with commercial organizations that pay for themselves. On a national scale, educational organizations are profitable. Education in the USSR ranked third in terms of efficiency after science and tourism. In accordance with the study of the effectiveness of education by Academician S.G. Strumilin in 1987 (report of the All-Russian Science and Technology Center). The cost of education in the USSR in a secondary higher educational institution was 4,200 rubles. The standard salary of an engineer, a university teacher and the standard pension of a specialist with a higher education was 120 rubles per month. The specialist

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paid for his training in 2 years and 2 months. Education in the USSR was not free, but education on credit. A regular loan ends after the end of the term and repayment of the loan. In the USSR, specialists repaid the loan for the rest of their lives. Therefore, they brought huge profits and education in the USSR was effective.

At the same time, the real estate and property of the education system does not differ from the real estate of other industries. However, the non-commercial orientation of state educational organizations requires the use of different criteria for assessing their effectiveness and management than for assessing the effectiveness of commercial firms.

There are a number of trends in modern education and property management. The first trend is the growth of accumulated and information. This trend in the "small" has led to the second trend – the use of information technologies and information systems in management. This trend in the "big" has led to the third trend – the problem of big data (Fan et al., 2014; Lyovin, Tsvetkov, 2017). The increase in the volume and structure of the accumulated information has created the complexity of data and the difficulty of managing such data. The complexity of data and management models is achieved through the universalization of their description and through the development of new models and technologies. Such new models and technologies of management are models of information units (Ozhereleva, 2014; Tsvetkov, 2014), information semasiological models and information semasiological technologies. Up to the present time, semasiological technologies have been widely used in linguistics. There are attempts to apply them in the information sphere. This article develops this direction

2. Results and discussion

System of Units of Semasiological Modeling

In many types of analysis and modeling, formal systems of signs or systems of units are used. Such an experience exists in cartography, where cartographic symbols are used in the construction of maps. Such is the case with applied computer science. Such symbols are called information units. The use of information units reduces complexity and increases the comparability of models and technologies.

There are two approaches to the use of information units. The first approach is used in the study of reality. It is called onomasiological (Pavlov, 2019; Bolbakov et al., 2022). It is based on the detailing of the information set to the level of universal information units. This approach is called "from the general to the specific" Another approach of modeling is called semasiological. It is based on the construction of control models and technologies from a system of universal units or an alphabet. This approach is called "from the particular to the general." This is how word formation occurs in natural languages. The semasiological approach uses rules for word construction and complex models. The semasiological approach is used in computer-aided design systems. In it, drawings and models of objects are designed from graphic primitives.

At present, a field approach is used in computer science and geoinformatics. This approach is based on the use of the model of the information field and the geoinformation field (Bolbakov et al., 2022) as a large information model. A field has indivisible elements. These field elements are information units. Thus, information units can be considered as one of the principles of strategy-based semasiological modeling.

Types of modeling and information units.

There are different types of modeling (Bonate, 2006) that use different kinds of information units. One of the taxonomy of modeling is based on the relationship of the modeling to the source of the modeling. The initial source of modeling is the information set and the information field. In the information field there are images of modeling objects. It is necessary to distinguish between the source of the simulation and the image of the modeling. If the source of OM is a substantial object, then such modeling is called object modeling (Kosova, 2022). Object modeling, in which a system approach is used, is called system-object modeling. If the source of modeling is a process, then such modeling is called processual. If the source of the modeling is the content of the object, then such modeling is called semantic. If the modeling source is the properties of an object, then such modeling is called attributive modeling.

Object modeling uses form and content. Object modeling is used to solve many problems (Tsvetkov, 1991). Modeling requires the use of model elements. These elements simplify model construction and analysis. Such elements are information units. Object modeling uses structural and semantic information units.

Process modeling (Raev, 2018) is also widely used. Process modeling is used in management. When building processes, you also need to use process elements. Process elements also simplify process analysis. Such elements are procedural information units.

In addition to object modeling, there is content modeling or semantic modeling (Song et al., 2022). Semantic analysis of information also requires the introduction of semantic elements. Such elements are semantic information units. Semantic modeling uses only content.

Structural modeling is a type of modeling. It uses structural information units. Structural modeling uses only morphology.

Meta modeling is one of the types of modeling. It uses meta-models and a variety of information units.

Conceptual modeling is a type of modeling. It uses information constructs as conceptual models and conceptual information units.

Agent-based modeling is a type of modeling. It uses agent models as simple and compound information units.

Heuristic modeling is a type of modeling. It uses heuristics and heuristic procedural information units.

Thus, many types of modeling and analysis require the use of information units.

The development of society is characterized by globalization (Tsvetkov, 2005a), automation, and informatization. The dominant factors in the development of society are informatization and digitalization. All these areas are connected by computer science. Modern Informatics (Gospodinov, 2023) combines different scientific areas by methods of analysis, information approach, and modeling methods. Informatics is an integrator of methodological research. The tasks of computer science are: the acquisition of knowledge (Holzinger, 2019), the formation of a picture of the world, the extraction of spatial knowledge, the identification of latent knowledge and the transformation of tacit knowledge into explicit knowledge All types of knowledge require if possible, it is necessary to create an element of knowledge. Such elements of knowledge are semantic information units.

Information models form information (Tsvetkov, 2005b) and intellectual resources (Zhang et al., 2017). There is a need to create elements of such resources. The elements of information resources are information units.

Situational analysis is now widely used. Situational analysis is required when solving management problems. Situational analysis is performed when building a model of an information situation. Situational analysis is used to identify relationships and connections. Situational analysis requires the application of elements of analysis. The elements of situational analysis are information units.

Exploration of the world around us begins with the collection of information. The main method of gathering information is monitoring. In monitoring, information units are needed to systematize the collected information.

After collecting information, applied problems are solved. These tasks are divided into two groups: cognitive tasks and applied tasks. Important tasks are aimed at developing models that form a picture of the world. However, these models also need to be reconciled. Such alignment is possible if the models are created within a single system. Such a system of complementary writing is a system of information units.

Applied modeling tasks include: construction of applied systems, maintenance of applied systems, solution of applied problems, information support in other applied areas. In order for the results of the constructions to be comparable and analyzable, it is necessary to choose a single description system. Such a system of description is the system of applied information units.

In the process of research, information from the real field and space is transferred to the information field and creates an information set. An information set is originally an unsystematized representation of the real world, like a photograph. For subsequent use and transformation into models and for obtaining knowledge, it is necessary to create a system for analyzing and describing the elements of the information set. The elements of analysis and description of the information set are information units.

Information systems (IS) and geographic information systems (GIS), as well as databases (DB) are widely used in the research process. These systems operate on ordered pieces of information and ordered operations. Chunks of information and operations are made up of units. These units are information units. Information units are necessary for the operation of information systems. The operation of a computer is based on the use of information units. Computer information units are machine operations and machine words.

The general conclusion is that information units are the basis for modeling and applying methods of informatics in practice. There is no universal system of information units, nor is there a universal language of humanity. Information units form systems in relation to the subject area and the area of research tasks. Complex objects and their models are divisible. It makes it possible to divide them into parts and elements.

In the information field, information models are a reflection of real processes and objects. In geoinformatics, models are represented in the form of digital maps and digital models. To transform models, it uses information morphism. Information morphism carries out a transformation on the basis of information units. In the theory of information units (Todorova, 2023), there are two areas of use: onomasiological (detailing of units) and semasiological (integration of units). Accordingly, two types of modeling are used: onomasiological (OM) and semasiological (SM).

The basis of OM modeling is the study design. The main idea of onomasiological modeling is detailing. At the first stage, clusters or, if possible, objects are isolated from the initial information set. Clusters are transformed into models, models are transformed into parts. On the basis of the selected criterion of divisibility, indivisible elements or information units are obtained. Most applied research is completed at the level of the formation of models and their parts. A complete study involves obtaining indivisible elements of models. In the information field, such models are information units (IUs). In OM technologies, UI elements are the result of modeling. In practice, OM is implemented using the oppositional (Cohen et al., 2016) and dichotomous analysis.

The main idea of semasiological modeling is integration and construction. The basis of SM modeling is the design or design plan. At the first stage, SM technology identifies information units as the basis of the project. Such UIs form systems. For example, in cartography, these are systems of conventional cartographic signs divided into three classes: area, linear, and point. In the programming of the UI system, there are elements of flowchart algorithms. In linguistics, it is the alphabet and thesaurus. Different languages have their own alphabets, i.e. their own UI systems. In the theory of image processing, information units are pixels, voxels and tiles. In computer-aided design theory, graphical primitives form a UI system.

In the second stage, the UI is transformed into parts or aggregates. Models are formed on the basis of aggregates. On the basis of models, a project and, if necessary, a material object are formed. In SM technologies, UI is the starting point of modeling.

When analyzing a text, there are different information units that are formed using different criteria of divisibility. The structural division results in the information unit symbol. The symbol, as a rule, has no meaning. In image processing theory, the structural unit of a flat bitmap image is a pixel. The semantic division of the text leads to the information unit "word". A word has a meaning, so it is an elementary semantic information unit. The word system is included in the thesaurus. Cartographic symbols are also elementary semantic units. The word (SL), taken by itself, has the initial vocabulary formy or lemma.

A word (W) is made up of symbols (Sm), connections between them (Con), has meaning or semantics (Sem), and has a dictionary form (Lem). A more complex semantic information unit is the sentence (Sen). A sentence is made up of words. A sentence (Sen) consists of words (Ws), relations between them (Rel), prepositions (Pret), a word has a case form (case form)), the sentence has a predicative meaning (pred-me) and has a syntax in the construction of words (sint). A more complex semantic IE is the phrase (Phr). A phrase is made up of sentences. Phr consists of sentences (Sen), relations between sentences (Rel), predicative meanings (pred-me), context (Cont), references (Ref), and syntax.The key features of a word are semantics. The key features of a sentence are the relationship between words and the predicative meaning. The key features of a phrase are context and references.

Information units can have dimensions. Figure 1 shows flat and volumetric information units.

Figure 1a shows a flat information unit pixel. Figure 1b shows voxel (Caon, 2004). It is fundamental that information units are formed as a local system.

Fig. 1. Information units of different dimensions

Semasiological control technology.

Semasiological technology of real estate management is based on the use of procedural units, semasiological procedural models and corporate management technology.

The semasiological technology of real estate management includes two stages: preparatory and operational. The preparatory stage includes the creation of a system of procedural and information units and semasiological management models. The operational stage of management includes the development of management decisions and the implementation of management.

Modern real estate management technology has specific trends and features. The main trend is the surge in the development of digital real estate technologies. These innovative technologies involve different approaches. For example, they are called PropTech (real estate technology). They can apply effective real estate portfolio management (e.g., VTS) in different ways. They offer new ways to rent a home (e.g., Airbnb) or hassle-free maintenance (e.g. FixFlo).

There is a trend of applying smart real estate management and creating smart real estate. There is a trend of moving from Facility Management (FM) to Corporate Real Estate Management (CREM) (Appel-Meulenbroek, Omar, 2021). The direction of real estate lifecycle management is developing. It is worth noting the use of Internet of Things technology in real estate management. The last two directions are due to the development of information support for real estate management (Gross, Tuyet, 2019) and information modeling. The International Property Management Association (IFMA) divides property management into asset management, property management, and facility management.

Real estate management of educational organizations is a technological integrated complex for meeting the information needs of the state and the population in educational services and the creation of qualified specialists. The state is both the consumer of the products of the Ministry of Education and the organizer of the education system.

The key parameters of real estate management include the needs for education of the population and the needs of the state for human resources. Interest on the part of the consumer of educational services is aimed at identifying similarities and differences between educational organizations, the economic costs of education and the opportunity costs of educational alternatives. Semasiological property management is a new technology in this field.

3. Conclusion

The management of real estate in educational organizations relies on information support. Modern information support for real estate management includes the use of information and intellectual technologies. These technologies have changed the mechanism of real estate management towards its digitalization. There is a distinction between design, executive and computing technologies of real estate management. Design and executive technologies of real estate management include semasiological management. Semasiological management refers to management technologies and is direct management. Information support for property management also uses semasiological modeling. The term "semasiological modeling" is borrowed from the field of linguistics. It characterizes the interdisciplinaryknowledge system. Semasiological modeling is one of the control support technologies. Semasiological modeling in real estate management uses information units as the basis of management technology. Semasiological modeling simplifies the verification of management processes and increases the reliability of management.

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Ontologies in Information Retrieval

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Abstract

The article explores information retrieval technologies. The difference between information retrieval and information retrieval is shown. The search for information includes: information retrieval, semantic retrieval, and ontological retrieval. The problems of existing information retrieval technologies are described. Nine reasons for the inadequacy of information retrieval are described. A brief systematics of information retrieval methods is given. Current trends in the development of information retrieval are described. The article proves that the existing technologies of information retrieval are morphological. Work in the field of semantic search has led to the search for semantic information, but has not led to the creation of semantic search technology. The concept of complete information retrieval, which includes the search for morphology, content and ontology, has been introduced. The problems of the development of semantic search are described. The paradigms of informational, semantic and ontological search are given. It is shown that information retrieval is one-level and morphological. Semantic search is two-level. Ontological search is multi-layered. The key parameters of sematic and ontological search are highlighted: terminological relations, meaning of meaning, concept, knowledge. A search alternative is marked: the alternative is either a short time and a high volume of results, or a long time and a smaller volume of search results.

Keywords: information set, morphological search, semantic search, ontological search, content.

1. Introduction

The number of data in the Internet is growing exponentially (Azad, Deepak, 2019). Then the reflection. For example, problems in Big Data (Levin, Tsvetkov, 2017; Hariri et al., 2019). Limited growth of information is outpacing the growth in the number of methods to extract desired information (Azad, Deepak, 2019). Informational search is now the main tool for extracting information (Guo et al., 2020) in the network and in information storage systems. Informational network search doesn't yield adequate results in a row reasons. The first cause is polysemy. It consists in the fact that search patterns, or keywords submitted by a user can relate to multiple topics. In result polysemy search results can be are not focused on the topic of interest.

The second reason for the inadequacy of search results is the presence of information uncertainty. Information uncertainty is the standard state of search. In scientific research, search information is always known approximately. The research is characterized by information uncertainty. Information uncertainty at the beginning of a search leads to inaccuracy or irrelevance of search results.

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The third reason for search inaccuracy is the length of the query and has to do with time. The query may be too short for the search engine to properly understand the meaning of what the user is looking for. The reason is subjective. The shorter is the query, the faster is the search. In practice, the average size of a web search is 2-4 words. The fourth reason for the inaccuracy of information retrieval is cognitive. It is caused by the lack of confidence and competence of the user. Under these conditions, the user is often unsure of what he is looking for until he sees the results. Even if the user knows what they are looking for, they don't always know how to compose correctly Request.

The fifth reason is the poor use of semantic relations and the poor use of auxiliary terms. Misuse of relationships distorts the meaning and renders the results of an informational slip useless.

The sixth reason for the inadequacy of the search is that information retrieval, which is morphological, is widely used. As a result of the search, an information set is formed according to morphological, not semantic features.

The seventh reason for the inadequacy of information retrieval is that the search methods do not take into account and do not assess the factor of information uncertainty.

The eighth reason for the inadequacy of information retrieval is that the overwhelming majority of search methods, with the exception of artificial neural network methods, do not use the ontological approach and the method of ontologies.

The ninth reason for the low efficiency of information retrieval technologies is the lack of methods that use different methods that take into account the criteria of "correspondence to meaning".

These reasons motivate the improvement of existing search methods, the development of new methods and new models of information retrieval. Such new methods include models of ontological search.

2. Discussion and results

Features of information retrieval.

Information retrieval as a technology is referred to the field of applied informatics (Polyakov, Tsvetkov, 2002) and is classified as a specialized information technology. Specialized information retrieval systems are used for information retrieval (IR). Retrieving information is a must for many applications, such as scientific research, dissertation research, digital library work, expert search, web search, etc.

Analysis of publications in the field of information retrieval indicates a growing trend of diversification of information retrieval methods. A significant part of the work is not integral. This is due to the fact that in many literature sources there are no clear requirements for identifying evidence of the truth of the information found. In information retrieval, the methods of correlation analysis (Tsvetkov, 2012), oppositional analysis (Tsvetkov, 2014a), dichotomous analysis (Kudzh, 2017) are not used. Therefore, the generalization of methods and the theory of information Searches are currently a challenge.

Existing models of neural information retrieval were often studied under homogeneous and narrow conditions, which significantly limited the understanding of their application for heterogeneous information (Thakur et al, 2021). Most web-based information search queries fall into the following categories (Azad, Deepak, 2019).

1. Information queries covering a broad topic, for which there may be thousands of alternative results.
2. Information requests covering a narrow topic that cannot be disclosed within the scope of the request, but can be disclosed by auxiliary iterative requests.
3. Navigation queries: Queries that search for a specific website or URL.
4. Transactional requests: Requests that demonstrate the user's intent to perform a specific action.

The first and second points are dominant. They are characterized by information uncertainty and the absence of semantic search criteria.

At present, the results of information retrieval are processed mainly using indexes and ontologies. At the same time, the use of ontologies in queries is not practiced. The use of ontologies is based on exact matches and is hidden from users. The use of morphological queries leads to the problem of terminological ambiguity (Tikhonov i dr., 2009). Morphological queries and search index are not based on the same set of terms. This is also known as dictionary problems (Furnas et al, 1987). Deficiencies in information retrieval technologies motivate the transition to new methods. One of the new methods is the advanced query method (Azad, Deepak, 2019). It also uses conditional relevance feedback. This idea is to incorporate user feedback into the search process to improve the end result. In particular, the user provides feedback on the received documents in response to the initial request, indicating the relevance of the results. This idea is based on the inclusion of the cognitive space of a person in the space of information search. The main task of the search is the correspondence of meaning, but it is not yet explicitly designated. If we detail this task, we get a scheme of complete information retrieval.

Morphology-semantics-ontology.

The classical search is morphological, that is, it is built by searching for matches of morphological forms. It can be considered as the first and not the final stage of the search.

Search for semantic information

The search for semantic information is the second stage of complete information retrieval. There are works on semantic search (Raphael, 1964; Pejtersen, 1998). This was the work of the early years, when researchers naively thought they were doing a semantic search. But analysis shows that this is what was called "semantic search", but the search for semantic information (Amati, van Rijsbergen, 1998). The search for semantic information as an object and "semantic search" as a technology belong to different categories and cannot be identified. Therefore, the original direction of semantic search is now more accurately defined as the search for semantic information (Chebil, Soualmia, 2023).

A number of papers (Amati, van Rijsbergen, 1998) have attempted to use "semantic information theory" (SIT). This theory was created as an alternative to the information theory laid down by the works of C.E. Shannon. The SIT has not been finalized. Its interpretation is not definite. Vaguely: It was built very broadly and vaguely. SIT relied on research in the field of polysemantic logic and philosophy, but not on formalism in the field of computer science. And the use of the term "information" was used to denote the description and transfer of this description from one subject/object to another (Amati, van Rijsbergen, 1998). General the difference between SIT and C.E. Shannon's theory of information is that information is conveyed not by an ordered sequence of binary symbols, but by means of a formal or natural language in which logical statements are defined and explained by semantics. However, these ideas have not been implemented to this day and have remained as wishes. They are useful for semantic search. However, it should be noted that in reality there is a search for semantic information.

The ontological approach to information retrieval should be noted as a promising direction (Mustafa et al, 2008). Semantic methods of information retrieval must understand the meanings of the concepts that users specify in their queries. However, the main drawback of existing methods of semantic information retrieval is that none of them takes into account the context of the concept (Mustafa et al, 2008). To solve this problem, the approach of thematic similarity is used. It is used to search for information to capture the context of a particular concept. In addition, source metadata in the form of RDF triples is used.

The concept of relevance is a hot topic in the process of searching for information. In recent years, the dramatic growth in the number of digital documents has highlighted the need for new approaches and more effective methods to improve the accuracy of IR systems to meet the information needs of real users to measure the semantic relationship between words. This approach is based on ontologies presented using a common knowledge base to dynamically build a semantic network. This network is based on linguistic properties and, when combined with a metric, creates a measure of semantic connectivity.

The problem of semantic search in biomedical digital libraries is described in (Ebeid, Pierce, 2021). It uses a vector approach to search. It describes a method based on knowledge graph embedding, which provides semantic relevance search and ranking of biomedical literature indexed in PubMed.

Chebil and Soualmia (2023) provide a relatively complete approach that includes a query extension technique. The approach proposed in this study combines probabilistic networks (PN), vector space model (VSM), and pseudo relevance feedback (PRF) to evaluate and add relevant concepts to the user's original query index. First, query extension is done using PN, VSM, and domain knowledge. Then, in the second step, PRF is used to enrich the query user using the same approach used in the first phase of the extension. To evaluate the performance of the developed system, called the Conceptual Information Retrieval Model (CIRM), several query extension experiments are conducted. Experiments have shown that the use of two measures of possibility and necessity in combination with cosine similarity and PRF improves the process of information retrieval. In all of these methods, such a search is not complete. It excludes the issues of finding latent information and tacit knowledge (Bolbakov, 2016).

Basics of semantic search.

Semantic search is based on the idea of semantic environment (Tsvetkov, 2014b) and semantic modeling. The ideas of semantic modeling go back to the work of Carnap (Carnap et al., 1953) and Luciano Floridi (Floridi, 2004). Carnap's works can be interpreted as wishes: "what should be and what would be desired". A more fundamental approach is proposed by L. Floridi. He introduces the concepts of "Strict Semantic Information Theory" (TSSI) and "Weak Semantic Information Theory" (TWSI). TSSI is based on truth values, not probability distributions. TWSI is based on probability distributions and actually describes C.E. Shannon's theory of information. There is a paradox, also revealed in (Tsvetkov, 2014c), between content and information volume. Floridi (2011) examines the relationship between "Semantic Information and Theory and Correctness of Truth". Floridi associates probabilistic characteristics with semantics, which is conditional and limits the theory. The main inaccuracy of L. Floridi in the Interpretation of the Concept of Truth. In the actual practice of "Truths a" there is a conditional concept. For a long time, the world was described by a geocentric system. This was believed to be true. But scientific research has led to a different model of the world, the heliocentric one. These models and the truths based on them contradict each other. Another example is the geometry of Euclid and Riemann. These models are not consistent, but complement each other. Semantic information is there But epistemologically, semantic information does not change and does not depend on interpretation or truth criteria

With regard to semantic information theory or complete information theory, one can agree with the opinion (Zhong, 2017). "Information (an information model) that is truly useful to people should consist of three components: a form called syntactic information, a meaning called semantic information, and a utility called pragmatic information" (Zhong, 2017). A fourth component, the ontological, should be added here. The "Information" term is amorphous. A more accurate term in the field of information retrieval is "information model". An information model has integrity, limitation, and structure. The ontological component of the information model is that it must conform to generally accepted concepts and contain particular and general knowledge. Concepts and general knowledge are ontological factors.

The quote above allows us to move on to the morphology of information models (Jeulin, 2021). The topic of morphology is still considered separately from the theory of information and from the theory of information modeling.

Paradigms of information and ontological search.

Information search is the simplest, but it is also divided into categories. It is based on structural information units (SIU), patterns (P), information set (IS), information clusters (IC), comparison methods (CmM), and search results set (SSR).

$$SIU \rightarrow P \rightarrow IS \rightarrow IC \rightarrow SSR \quad (1)$$

Paradigm (1) is interpreted as "one pattern – one set of searches". Paradigm (1) has two implementations for complex patterns P(A, B)

$$SIU \rightarrow P(A, B) \rightarrow IS \rightarrow IC \rightarrow (SSR(A) \cup SSR(B)) \quad (2)$$

Paradigm (2) is interpreted as follows: "one pattern – several sets of search results". Paradigm (2) is found in simple search engines, such as searching for files in the Windows operating system. If the search pattern includes two words, then all the words in the pattern are searched independently. The search result consists of a collection of sets for each word in the pattern. This search method takes little time but creates large amounts of information that the user must analyze on their own. The load is transferred to the cognitive area of the person.

Another search paradigm takes into account the terminological relationships (R) between the words of the pattern. For example, consider two words as in paradigm (2)

$$SIU \rightarrow P(A, R, B) \rightarrow IS \rightarrow IC \rightarrow SSR(A, R^*, B) \quad (3)$$

Paradigm (3) is interpreted as follows: "one pattern with relations – one set of searches with reduced relations (R*)". Paradigm (3) is found in the search engines of the word processor Word. If the search pattern includes words and relationships, the search result contains a simplification or modification of the relationship, but with the words included. Paradigms (1-3) describe morphological search.

To implement semantic search (SR), you need to specify a meaning value (MM). The principal difference between semantic search is the presence of two levels of search.

$$SIU \rightarrow P(A, R, MM, B) \rightarrow IS \rightarrow IC \rightarrow SSR(A, R^*, B) \quad (4)$$

$$SSR(A, R^*, B) \rightarrow SmS(A, R^*, MM^*, B) \quad (5)$$

The first level of search (4) is morphological. The second level of search is semantic. The result of the search is a set of meanings that do not exist in paradigms (1-3). The result of semantic search (5) is a semantic set (SmS). A feature of expression (5) is that the value of the meaning at the start of the search (MM) may differ from the value of the meaning at the search result (MM*). The criterion for the relevance of semantic search is the relationship

$$MM \approx MM^* \quad (6)$$

Ontological search (OR) differs in the number of levels and the result of the search.

$$SIU \rightarrow P(A, R, MM, B) \rightarrow IS \rightarrow IC \rightarrow SSR(A, R^*, B) \quad (7)$$

$$SSR(A, R^*, B) \rightarrow SmS(A, R^*, MM, B) \quad (8)$$

$$SmS(A, R^*, MM, B) \rightarrow SO(C, Kn, R^{**}, MM^*) \quad (9)$$

Ontological search contains the first level of morphological search (7), the second level of semantic search (8), and the third level of ontological search. The results of morphological typing and semantic search are commensurate because they describe the same objects with different completeness. The results of the ontological slip (9) and the morphological search are qualitatively different, since in the ontological search we find not objects, but: concepts (C), knowledge (Kn), generalized relations (R**), generalized meaning (MM*). All generalizations go beyond a single object and describe a group of objects. Ontological search is based on semantic search, correspondence of meaning, and conceptual modeling. Expressions (8) and (9) can have sublevels. Therefore, the scheme (7-9) is multi-level.

3. Conclusion

The problem with all types of searches is the complexity, search time, and volume of search results. Complexity reduces search time. In search engines, there is an alternative, either a short time and a high volume of results, or a smaller volume but a longer search time. Ontological search has a greater number of levels of search and analysis. The semantic and ontological levels include analysis as part of search. The conducted research gives grounds to introduce the concepts of "morphological search", "semantic search", "ontological search". There is reason to consider the existing information search to be morphological. Morphological factors play a major role in it. Semantic search involves semantic analysis. Ontological search involves generalization and conceptual analysis. All types of search reduce information uncertainty. Morphological search is the simplest because it uses a well-formalized space of parameters. For informational, semantic, and ontological models, morphology determines their representation. With semantic search factors are little used in search technologies as well. Orthology can define the structure of a model or object. The semantics of information models is determined by their content and relation to reality. The relation to reality determines the conditional truth. Summing up, it should be stated that the concepts of information retrieval and information retrieval are not identical. Information retrieval is one technology with one level of retrieval. Information retrieval includes different technologies with a large number of levels of search and analysis. Searching for information yields results that fall into different categories.

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Economic and Technical Analysis of the Use of High-Performance Motor in Mining in Vietnam

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Abstract

Reducing the cost of using electricity in mining to improve production efficiency is one of the most urgent tasks not only for other industries but also for the mining industry in Vietnam today. In the past years, the mining industry has applied many technical solutions to save energy in mining, such as using inverters to adjust the working process, using soft starts, and using a power metering monitoring system. The electric motor is the most energy-intensive driving device, accounting for about 70-80 % of the mine's electricity consumption. The use of high-performance motors to directly replace traditional induction motors with low-performance ones in mining will bring about high efficiency. The content of the article presents the possibility of using a line-start permanent magnet synchronous motor (LSPMSM) to replace traditional three-phase induction motors. At the same time, the article aims to analyze the economics and techniques of applying LSPMSM in mining to develop a reasonable investment plan to improve the use of electricity in mining.

Keywords: mining, high-performance motor, electricity.

1. Introduction

Currently, the capacity and depth of mining are increasing, leading to more and more machines being used in mining to replace human labor (Ranjith et al., 2017). Ha Lam mine in Vietnam is equipped with a mechanized longwall with a capacity of 1.2 million tons of coal and a mechanized furnace with a capacity of 600,000 tons of coal (Nguyen et al., 2020). Nui Beo mine is equipped with a synchronous mechanized longwall with a capacity of 600,000 tons of coal per year (Vu, 2022). The mechanization of mining leads to an increasing use of electricity in mining, making the proportion of electricity cost per ton of mined coal increasingly large.

Reducing the cost of using electricity in mining to improve production efficiency is one of the urgent tasks not only for other industries but also for the mining industry in Vietnam today. In the past years, the mining industry has applied many technical solutions to save energy in mining, such as using inverters to adjust the working process, using soft starts, and using a power metering monitoring system (Do et al., 2022a).

The above solutions have also been partly promoted and are effective in using energy efficiently. However, the majority of the electricity consumed in mining goes to electric drive systems (Semenov et al., 2019). An electric motor is a driving device used to generate the drives for

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mining operations. In mining in Vietnam, the electrical energy consumed by the electric drive accounts for about 70-80 % of the total electricity consumed by the mine (Bui et al., 2022; Do et al., 2022a; Do et al., 2022b; Maraaba et al., 2018). The use of high-performance motors as a direct replacement for low efficiency traditional induction motors in mining has not yet been implemented. The content of the article goes into an economic and technical analysis of the application of high-performance motors in mining.

2. High-performance motor

According to the IEC 60034-30 standard motor efficiency is classified into classes: IE1 – Standard Efficiency (IE1 – Standard Efficiency), IE2 – High Efficiency, IE3 – Premium Efficiency, IE4 – Super Premium Efficiency, IE5 – Ultra Premium Efficiency. According to (IEC, 2014) the efficiency levels from IE1 to IE5 of the motor depending on the power are shown in Figure 1.

Traditional motors used in mining are squirrel cage rotor induction motors (IM). This type of motor has many advantages such as: simple structure, high durability, large starting torque, low cost (Putro et al., 2023). However, the major disadvantage of these types of motors is that it is difficult to improve efficiency because there is still power loss on the rotor during operation (Dursun et al., 2018). It is really difficult to improve IM performance to IE2, IE3 level according to IEC60034-30 standard.

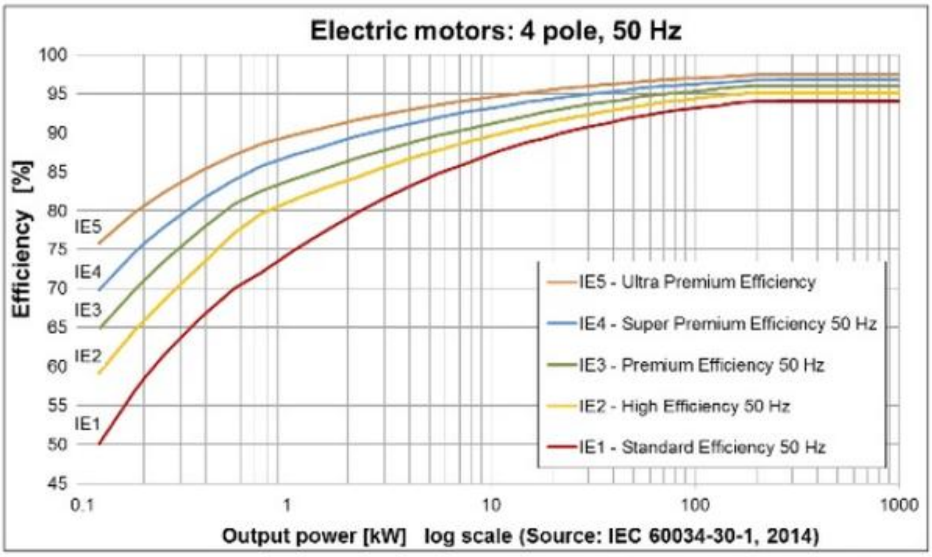

Fig. 1. Dependency between efficiency level and motor power

Nowadays, with the development of rare-earth magnet materials, many types of high-performance motors such as the line-start permanent-magnet synchronous motor (LSPMSM) are created (Ugale et al., 2014). LSPMSM has the advantages of high-performance, large power factor and does not need a starter, but has the disadvantage of low starting torque, so it is only suitable for technological stages with small starting torque requirements (Behbahanifard et al., 2015; Ganesan et al., 2019).

To be able to use LSPMSM to replace traditional three-phase induction motors, It is necessary to have in-depth studies on technical factors and economic efficiency when applying this type of motors in mining practice.

3. Results and discussion

3.1. Technical analysis

As analyzed above, LSPMSM has the advantages of high-performance, large power factor, direct starting without the need for an attached controller. However, the disadvantage of this motor is the small starting torque.

The use of high-performance LSPMSM motors as an alternative to IM is of great significance when applied to power-intensive technology stages and technically appropriate. According to the report on electricity use in underground mining, currently, electricity is mainly used in the following stages: mining, ventilation, water pumping, excavation and transportation. For technological stages of transportation, excavation or mining, the speed of the replacement motor must be exactly the same as that of the previously designed motor. In addition, these loads often have large starting torques, so they are not suitable for LSPMSM motors. However, the ventilation and water pumping stages are the major power consumers and the small starting torque can replace the LSPMSMs for the IMs in use (Bui et al., 2022; Do et al., 2022a; Do et al., 2022b; Maraaba et al., 2018).

Analysis of technical characteristics of LSPSMSM with speed of 3000 rpm, rated power of 15kW, rated voltage of 660/1140V used with load as a local exhaust fan in mining. The simulation results are shown in Figures 2, 3, 4.

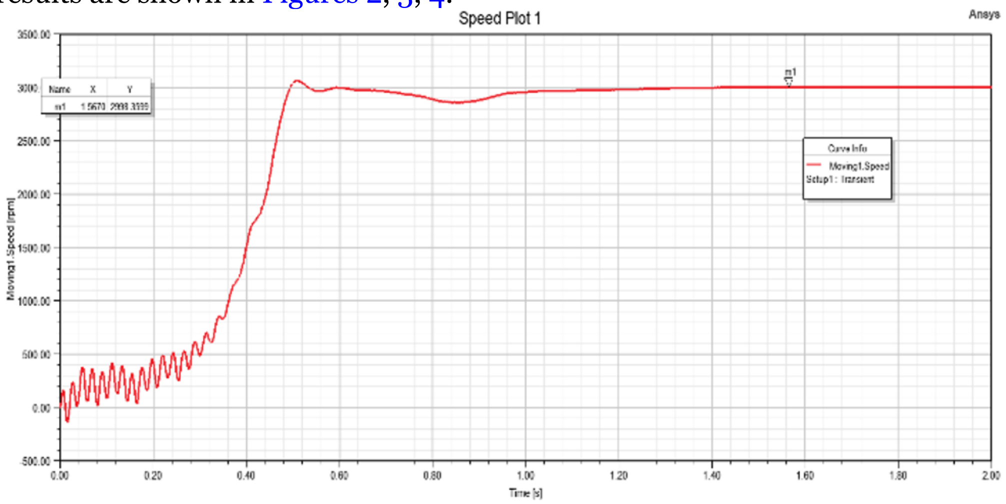

Fig. 2. Rated load starting characteristics of LSPMSM with power 15kW and speed 3000 rpm.

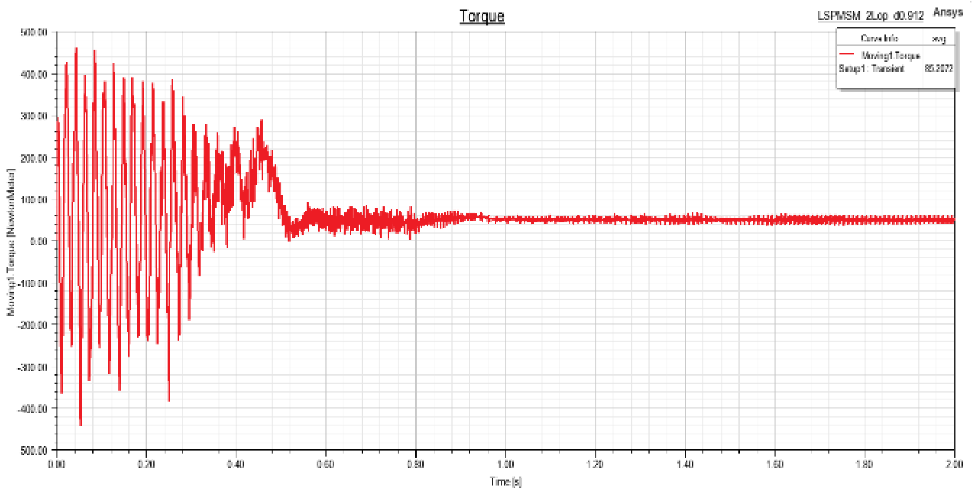

Fig. 3. Starting torque characteristics with rated load of LSPMSM

The results shown in Figure 2 show that the LSPMSM can be completely started with the blower loads, the motor's starting time is 1s. Figure 3 shows that the starting torque does not fluctuate. The motor current characteristics indicate that the starting current of the motor is small (Figure 4).

Thus, from the above specification analysis, it is found that it is possible to use high-performance LSPMSM to replace traditional IMs in the ventilation and water pumping stages of mining. This is the technology that uses the most electricity. The replacement can bring high economic efficiency, reduce power use and improve the power factor of the network.

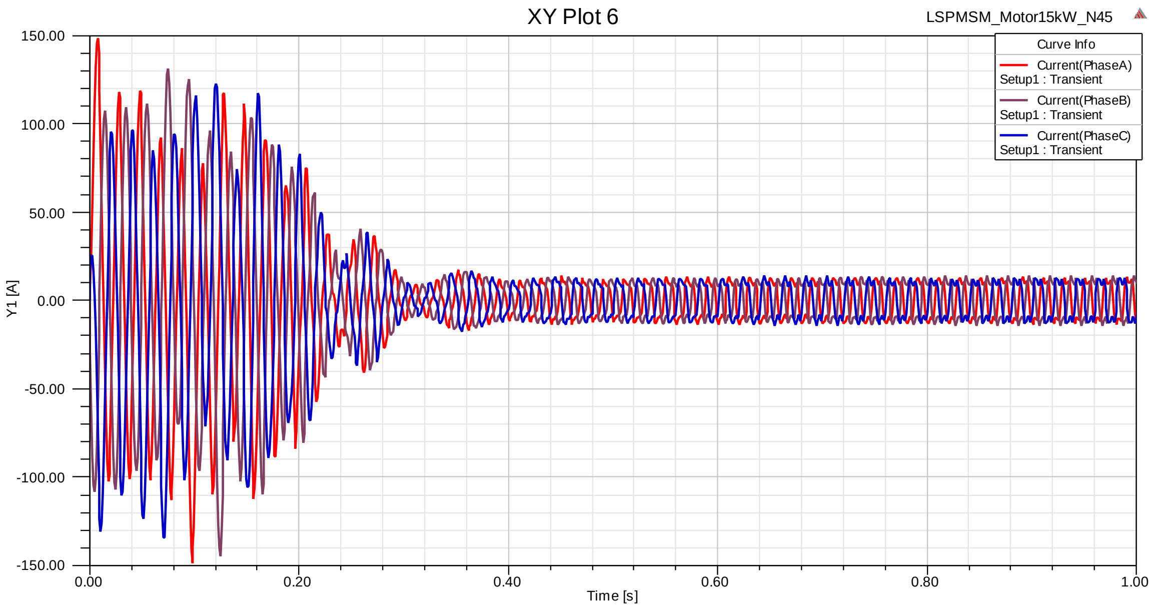

Fig. 4. Start-up current characteristics with rated load of LSPMSM

3.2. Economic analysis

The investment in high-performance motor will increase the initial cost, but will be recovered from the cost of saving energy during operation. In order to replace IM in mining with the high-performance LSPMSM, economic efficiency needs to be further considered.

Assume the mining powertrain is upgraded from IM with IE1 efficiency to using a motor with high efficiency IE_n (with n = 2, 3, 4). According to (Toda et al., 2014) the operating cost saved each year when using high-performance motor instead of IE1 efficiency motor is calculated according to the formula.

$$S = P_{out} \cdot C \cdot T \left[\frac{100}{E_1} - \frac{100}{E_n}\right] \qquad (1)$$

where: P_{out} – motor power (kW); C – Electricity price (VND/kWh); T – number of working hours per year (hours); E_n, E_1 – is the standard motor efficiency, respectively IE_n and IE_1.

The initial cost difference between two high-performance IEn and IE1 motors is determined by the formula (Toda et al., 2014):

$$\Delta C = m \cdot Y \qquad (2)$$

where: m – Differences in mass, material; Y – unit price difference.

The payback period is calculated as follows:

$$T_c = \Delta C / S \qquad (3)$$

From the above base, the study conducted to compare the economic efficiency obtained for local exhaust fans in underground mines, using the IM with IE1 efficiency and the LSPMSM with IE3 high-performance. Motors with specifications as shown in Table 1.

Table 1. Specifications of IM and LSPMSM

TT	Parameters	IM	LSPMSM
1	Power (kW)	15kW	15kW
2	Voltage (V)	660/1140	660/1140
3	Frequency (Hz)	50	50
4	Speed (rpm)	2960	3000
5	Motor efficiency (%)	89 (IE_1)	93.2(IE_3)

According to the document (Toda et al., 2014), the mass of the electromagnet required for the LSPMSM with power 15kW is about m_{PM}=1.85kg, magnet sale price NdFeB is P_{PM}=250$/kg equivalent 5.75 million VND/kg. Cost difference using high flux density steel foil for LSPMSM with power 15kW is m'_{PM}=4.5kg, selling price difference P'_{PM}=12$/kg equivalent to about 0.276 million VND/kg.

From formula (2) determine the initial cost difference between the high-performance LSPMSM and the standard IM as:

$$\Delta C=[m_{PM}\cdot P_{PM}+m'_{PM}\cdot P'_{PM}]=[1.85\cdot 5.75+4.5\cdot 0.276]=11.88 \text{ million VND} \quad (4)$$

Operational cost savings per year when replacing LSPMSM for IM with the formula:

$$S = P_{out} \cdot C \cdot T \left[\frac{100}{E_2} - \frac{100}{E_1}\right] = 15 \cdot 1600 \cdot 5000 \left[\frac{100}{89.3} - \frac{100}{93.2}\right] = 5.6\ million\ VND \quad (5)$$

where, electricity price C=1600 VND/kWh; Mining factory works three shifts T=5000h/year.

The payback period when replacing LSPMSM for IM of the local exhaust fan is determined by formula (1):

$$T_c=\Delta C/S=11.88/5.6=2.12 \text{ year} \quad (6)$$

Due to the energy saving during use, the replacement of the LSPMSM with power 15kW for the IM with power 15kW brings high economic efficiency, short payback period of about 2.12 years. In addition, the improvement of the power factor helps to reduce the loss on the transmission line, because the LSPMSM motor has a power factor of 0.95 or more compared to the IM with a power factor of about 0.85.

4. Conclusion

From the above economic-technical analysis, it is found that LSPMSM-type high-performance motors are technically suitable to replace the traditional low efficiency IMs used for exhaust fan or water pump loads. According to the analysis of economic profit, with the replacement of this high-performance motor, the payback period is more than 2 years, not to mention the benefits of power transmission lines and power sources.

In addition, the fan and water pump loads are the loads with the highest proportion of electricity usage in mining, accounting for over 30 % of the total electricity used in the whole mine. So this replacement will have a breakthrough in the efficient use of energy in mining.

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Information Field Elements

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Abstract

The article examines the elements of the information field. The main features of the information field as an integral information model are described. The tasks of the information field are described. The information field contains patterns and relationships of the real world. The information field contains tacit knowledge. The main tasks of the information field are to obtain new knowledge and form a picture of the world. It is shown that the information field can be considered as a system. The system has elements. The elements of the information field are information units. Information units are used as elements of models regardless of the information field. This justifies their use as elements of the information field. The variety of application of information units is shown. Information units are used in linguistics, programming, education, decision-making, and system analysis. Information units serve as the basis for information modeling. Four groups of information units that exist in linguistics and in the information field are described. A set-theoretic approach for describing information units of different groups is shown. The article describes the features of information construction. Information units as elements of the information field contribute to cognition and the formation of a picture of the world.

Keywords: computer science, information models, information field, information units, information construction.

1. Introduction

The information field (Tsvetkov, 2014a; Tsvetkov, 2014b; Raev, 2021) is a phenomenon of modern science. The information field (IF) can be considered as a complex model that reflects real fields and individual objects of reality. In the information field, disparate objects of the real world appear in a single information environment. IF can be compared to a snapshot of reality. In reality, objects are independent of each other. But in a photograph, the images of the objects form a single picture. IF describes objects and processes. IF describes the content of processes in real fields.

IF is related to the Information Space (IS). IF describes the content of the real world, and IS solves the problems of coordinating the information field and sets the spatial orientation of the information field processes. Field and space complement each other. IF and IS reflect the superposition of real fields (Barmin et al., 2014). Together, they form a primary picture of the world (Tsvetkov, 2020). The information field unites disparate objects and fields of the real world into a single descriptive model. Models of individual objects appear in a single information environment. IF contains tacit knowledge. It contains a description of the patterns of the real world. The information field contains a description of information and spatial relationships.

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Real-world relationships between objects and fields can be complex. In the information field, complex relations are reduced and can be supplemented by information relations that do not exist in reality. This makes it possible to divide information relations in IF into two groups. The first group of information relations describes the relations of reality. The second group of information relations supplements the descriptions to explain the patterns and make the description more consistent with reality.

An important concept of the information field is the field function (Tsvetkov, 2014a). This characteristic expresses the content of the information field at a given point according to the selected criteria. In general, the model of the information field is more capacious and meaningful in comparison with a photograph of reality, a snapshot. The snapshot contains explicit information. IF contains tacit information and tacit knowledge.

The information field can be represented as an integral model (Tsvetkov et al., 2023), which contains information models: systems, situations, objects, process models, patterns models. This complex model contains simpler models and the relationships between them. Each of the simpler information models, in turn, contains parts, subsystems, and elements. The elements of these information models are information units as indivisible entities of the information field.

The information field is not created arbitrarily, but is based on a number of correspondences between the real world and IF. The simplest correspondence is the information correspondence between models and objects. Next is the semantic correspondence between the content of the models and the content of the objects. In addition to informational and semantic correspondence, there must be an ontological or conceptual correspondence. When displaying processes in the IF there must be a procedural correspondence between real and information processes.

The information field, as a composite model, must solve special problems. The first task of IF is to describe objects and phenomena in the real world. The second task of IF is to form information models as IF objects. The third task of IF is to create an information environment for research and modeling. The fourth task of the information field is to acquire knowledge. In order to extract knowledge in the information field, there must be opportunities for metamodeling (Tsvetkov et al., 2020). The main task of the information field is to form a picture of the world.

Many models have the property of being systematic and can be considered as complex systems. The information field is systematic and can be considered as a complex system. Any complex system contains elements. Such indivisible elements of the information field are information units (Ozhereleva, 2014). Therefore, in order to study the information field, it is necessary to consider its information units. The problem of analyzing the information field requires the study of its indivisible elements, that is, information units (Raev, 2020).

2. Discussion and results

Information Units as Modeling Elements.

Modern information modeling is intensively developing. The development of modeling is expressed in the emergence of new information models. These models include an information field model.

Applied informatics and applied geoinformatics solve many practical problems with the help of modeling. And informational modeling is of great importance in geoecology. Different types of monitoring are used to monitor the environment: geotechnical monitoring (Carri et al., 2021), geoinformation monitoring, space monitoring. Information modeling is used in all types of monitoring. There is a direction of onomasiological information modeling (Pavlov, 2019). This type of modeling builds models of objects and processes by breaking them down into small elements. This modeling results in the formation of information units.

Information units as elements of models are used in applied informatics and applied geoinformatics. Information units are used in linguistics and programming. Information units are used in information theory (Ivannikov i dr., 2007). In a detailed analysis of real-world phenomena, information units are used implicitly. In the theory of the information field, there is a concept of information units, which denote indivisible elements of the information field. Any analysis involves division. Andthe political division can be carried out to parts or to elements. Dividing to elements actually creates information units. There are a large number of works describing information units or their applications. However, until now, no attempt has been made to write a general theory of information units. The first feature of information units is that they form specialized units groups when used in different technologies. For example, there are linguistic information units (Smith, 2006). There are communication information units (Fassier, Azoulay, 2010), and there are logical information units (Tajima et al., 1999), there are lexical information units (Almela, Sánchez, 2007), there are representational information units. There are paralinguistic information units (Tsvetkov, 2013). Thus, information units are used in the construction of models, in the construction of models, and in modeling.

Information Units and Set Theory.

The theory of information units uses the theory of information and the theory of information modeling. There are different approaches to the description of information units. The description of information units can be done using set theory.

Information units (IUs) are used in two directions when building models: decomposition and composition. Information units are used when dividing modeling objects or systems into elements. IUs are used in the construction of models and objects. The first direction in technology can be compared to disassembly. The second direction can be compared to assembly. There are different groups of information units. From the standpoint of set theory, units are elements of sets. In the field of linguistics, there are four groups of information units.

The first group includes symbols or structural information units $x_0 \in ANL$. The set of ANLs corresponds to the natural language alphabet.

The second group includes words or semantic (Guo, et al., 2019; Tsvetkov, 2014c) information units $x_1 Lex \in$. The Lex set corresponds to the vocabulary of a given language. Words have a semantic environment that explains the meaning of the word.

The third group includes sentences as collections of related words. Sentences are predicative information units $x_2 \in (Lex, Rel)$. The set (Lex, Rel) corresponds to the vocabulary of a given language and the set of valid relationships between words, including syntactics.

The fourth group includes related sentences or phrases. Phrases are phraseological information units $x_3 \in (Lex, Rel, Con)$. A set (Lex, Rel, Con) corresponds to the vocabulary of a given language, a set of valid relationships between words, a set of contextual expressions Con of a given language. In natural language, Con is expressed by pronouns, i.e. noun substitutes. There are relationships between units.

$x_0 \in x_1,$ Sint1 (1)

$x_1 \in x_2,$ Sint2 (2)

$x_2 \in x_3,$ Sint3 (3)

In expression (1), Sint 1 is the syntax for forming words from symbols. In expression (2), Sint 2 is the syntax for forming sentences from words. In expression (3), Sint3 is the syntax for forming phrases from sentences.

In the field of programming, the following groups of information units are distinguished.

Symbols or structural information units $y_0 \in APL$. The set of APLs corresponds to the alphabet of a programming language.

Operators or semantic information units y 1 ∈Lex1. The set Lex1 corresponds to the vocabulary of the operators of a given language.

Operands or semantic information units y 2 Lex 2. The set∈ of Lex2 corresponds to the vocabulary of the operands of a given language

Sentences or predicative information units $y_3 \in$ (Lex 1, Lex 2, Rel, Sint). The set (Lex 1, Lex2, Rel, Sint) corresponds to the allowable stock of clauses, according to the permissible relations Rel between and the valid syntax Sint.

In the field of system analysis, the following groups of information units are distinguished.

Elements of the system or structural information units $z_0 \in$ A Sys. The set ASys corresponds to the alphabet of the elements of the system.

Sets of elements or composite information units z 1 ∈Lex1. The set of Lex1 corresponds to the vocabulary of the constituent elements of the system.

Process Elements or Process Information Units $z_2 \in APSys$. The set of APSys corresponds to the alphabet of elementary processes in a given system

Blocks or predicative information units of the z_3 system ∈(ASys, APSys, Lex1, Rel, Sint). The set corresponds to the allowable stock of elements and blocks, according to the valid Rel relations between the elements of the system and the valid Sint syntax for constructing the structure of the system.

In the field of systems analysis, there are two qualitative types of information units: structural and processual. In linguistics, there is only one type of elementary information unit.

In the field of information analysis or information field theory, the following groups of information units are distinguished.

Elements of the information field or symbolic information units $w_0 \in AF$. The set of AFs corresponds to the alphabet of the elements of the field.

Composite Information Units or Information Models w 1 Lex 1. The set of $\in$Lex 1 corresponds to the vocabulary of the constituent elements of the field.

Process Elements or Process Information Units w_2 APr. $\in$The set APr corresponds to the alphabet of the elementary processes of the field.

Blocks or enlarged information models $w_3 \in$(AF, APr, Lex1, Rel, Sint). The set corresponds to the allowable stock of elements and blocks, according to the valid Rel relations between the elements of the system and the valid Sint syntax of building the model.

On the basis of generalization, the following general groups of information units can be distinguished.

Elements or symbolic information units $iu_0 \in AU$. The set of AUs corresponds to the alphabet of symbolic information units or the alphabet of the formal language of description.

Compound Information Units or Information Words iu 1 Lex 1. $\in$ Lex1 corresponds to the vocabulary of information words.

Process Elements or Process Information Units iu_2 APr. $\in$The set APr corresponds to the alphabet of elementary processes.

Blocks or enlarged information words $iu_{\in 3}$ (AF, APr, Lex1, Rel, Sint). The set corresponds to the allowable stock of elements and blocks , according to the valid Rel relations between the elements of the system and the valid Sint syntax of building the model.

Construction of IE in the information field.

Information units in IF are created by dividing the original set or by composing simple IUs. Division in the information field is performed from top to bottom, that is, from larger objects to smaller ones. Start dividing using categories. Different mathematical methods are used for this. The simplest method is to Method of separating hyperplane in parameter space. Then, the similarity/difference grouping is used. This method is implemented through cluster analysis. Within the cluster, division is performed using dichotomous analysis. Then the units are checked for dependency and independence. For this purpose, correlative (Tsvetkov, 2012) analysis and oppositional analysis (Luhar et al, 2014; Tsvetkov, 2014d) are used. The procedures for dividing the information set use information models.

As a result of dividing the initial information set, sets of division elements (ed) are obtained, which are checked for proportionality to information units and models.

Simple information units oiu are independent of and unrelated to other information units.

$(oiu_i = ed_i) \wedge (oiu_j = ed_j) = 0; i \neq j$ (4)

Compound information units ciu are a linear combination of simple information units.

$ciu = A1\, oiu_1 + A2\, oiu_2 + Ai\, oiu_i$ (5)

IM blocks or models are a functional combination of simple and compound information units.

$IM = F1(oiu_i) + F2\,(ciu_k) + F3\,(oiu_L, ciu_p)$ (6)

Design in the information field.

There is a difference in fission and construction models. When dividing, models are built according to the principle of "what exists". When constructing, models are built according to the principle of "what should be". Design in the information field is carried out "from the bottom up", that is, from small objects to larger ones. They start constructing using simple information units. The construction of information models is carried out according to the required functional features of the models. The use of information units entails the standardization of construction and the standardization of information exchange. Information units as standardized objects are stored in databases. It is necessary to note the specifics of information design in geoinformatics. This specificity is manifested in the "big" and "small"

In the "big" context, the specificity of geoinformatics lies in the integration of models and technologies by geoinformatics. In geoinformatics, groups of information units are used that are used in other sciences.

In the "small" context, the specificity of geoinformatics lies in the qualitative diversity of information units. Geoinformatics uses geodata (Zuo, 2020), which contains three types of data: place, time, and topic. Three types of data define three qualitative groups of information units. Another specificity of geodata is related to the processing of video information. Data models in GIS and geoinformatics have two forms of representation: visual and digital. Geoinformatics and GIS allow the processing of information in digital and visual form. For the visual form of models, universal information units are used: pixels, tiles, and patterns. For the "place" data group, information units are used in the form of coordinates of points and intervals.

The detail of information units and their semantics make it possible to extract knowledge. As a result of the use of information units and modeling, digital maps and digital models are created.

3. Conclusion

Information units are universal elements of analysis in the study of the world around us. IUs are the natural language equivalent of the alphabet. IUs are a means of describing objects, and this description provides comparability. This description extends to objects and to the general picture of the world. Information units are elements of many processes. IU is used for different purposes. IU is used as a tool to ensure the connection of the categories "information", "information resources", "knowledge". Information units are used as elements of semiotics. Semiotic signs are units of information. IUs are used as elements of application systems. IUs are used as elements of decision-making processes and as elements of decision support processes. IUs are widely used in education. In education, IUs act as didactic units. Despite the widespread use of information units, they are not always called information units. This hinders the generalization of the experience of their application and the development of the theory of information units. The study of information units is promising for the further development of computer science and the construction of a picture of the world. General conclusion: information units are elements of models and elements of the information field. IUs contribute to the knowledge of the world around us and to build a picture of the world.

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Informational Granular Analysis

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Abstract

The article offers a new type of analysis of complex heterogeneous situations. The article introduces a new information model, called a granular information model. The model has two categories of parameters. The first category of parameters defines the boundaries of the model and defines the commonality. The second category of models describes the specific properties of the model. On the basis of the information model, a new type of analysis is proposed – granular information analysis. The difference between this analysis and the methods of granular information processing is shown. For the granular information model, a set-theoretic description is proposed. Granules are considered as homogeneous sets in a heterogeneous field. Granules have homogeneous and heterogeneous parameters. When describing granules, there is an analogy with the description of geodata. Homogeneous coordinates define the boundaries of the granules. Granules are objects of real and parametric space. Inhomogeneous coordinates describe the quality and relationships in granules. The article introduces the concept of contextual structure. The contextual structure does not have a visual form of representation and can only be analyzed with the help of computer technologies and construction rules. The new model expands the range of solvable tasks of analysis and applied problems.

Keywords: modeling, analysis, information models, normative sets, granular model, information field.

1. Introduction

Information granular analysis is a new direction in the theory of analysis and the theory of information modeling. Granular computing is widely known (Yao et al., 2013; Bargiela, Pedrycz, 2022). Informational granular analysis is an analytical direction in analysis. Information granular analysis (IGA) is based on combination with other types of analysis. Among these types of analysis, the following should be distinguished: set-theoretic analysis, cluster analysis, qualitative analysis, comparative analysis, system analysis, and spatial analysis. IGA methods are (Rogov, 2020): composition, overlay, conceptual mixing (Savinykh, 2017), stratification, clustering, and others. Granular analysis is not limited to a single method or algorithm. IGA should be seen as an approach to finding patterns that exist in the real world. IGA is related to the information granular model and methods for its construction. The Information Nullified Model (IGM) is a complex model that is found in cluster analysis and is rarely found in set theory. The difference between

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IGM and other models can be shown using topologies. Most areal and cluster models can be described by a planar graph. In general, a nulled model is not described by a planar graph, but is a hypergraph in parameter space.

The aim of the IGA is to develop additional methods of analysis and reasoning methods. IGA can be referred to as gentle methods of information analysis (Zhang et al., 2020). Information analysis using granulation is closeto fuzzy calculations. Fuzzy information granulation and, in fact, the basics of granular analysis were first proposed by JI. Zadeh. The theory of analysis is based on fuzzy information granularity (TFIG) (Zadeh, 1979).

The basic idea of IGA is to isolate in space some homogeneous sets called granules. Granules are combined and their influence in the information field or in the real field on ongoing processes or on a situation is evaluated. In this way, IGA makes it possible to find cause-and-effect relationships, explain complex situations or processes, and predict further developments.

2. Discussion and results

A granule as a local set.

To describe information granules, let's introduce the concept of local set (LS). A local set has boundaries and two categories of elements: homogeneous P and inhomogeneous U (Figure 1).

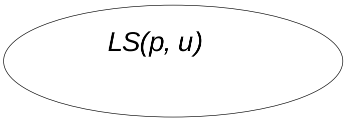

Fig. 1. Granule as a Homogeneous Set

Homogeneous elements of the granule differ, but have the same quality, describe the same indicator.The most striking example of homogeneous elements is coordinates. For example, homogeneous elements can be three-dimensional coordinates $p_1 = X$, $p_2 = Y$, $p_3 = Z$, or distance L. An example of a set of homogeneous elements would be a map or plan that has areal or line features. Map granules are areal features. When describing granules, there is an analogy with the description of geodata (Savinykh, Tsvetkov, 2014; Zuo, 2020). Homogeneous coordinates are analogous to coordinates that describe space. Inhomogeneous e coordinates are analogous to attributive coordinates.

In the information or geoinformation field, a granule is an information model. It can be called an information granule. An information granule is an information model that can be described as a local set.

The part of the granule that is defined by homogeneous coordinates is called homogeneous. A homogeneous part of a granule can be a volumetric object, an area, or a linear feature. For example, a section of railroad or a set of connected railways is an example of a linear granule. For homogeneous elements, $p_1 \cap p_2 \cap p_3 = \varnothing$. Homogeneous variables provide a coordinating basis or basis for analysis. They can be not coordinates, but any selected coordination parameters against which heterogeneous parameters are analyzed. Homogeneous elements or variables create a coordination system for heterogeneous elements.

Heterogeneous elements have different qualities. They can describe different metrics. Heterogeneous elements can be compared to the "load" parameter in geostatistics (Diggle et al., 1998; Emery, Maleki, 2019). For example, the density of rock in the volume of the soil, indicators of pollution of the reservoir with various chemicals, the concentration of harmful substances in the air, population density, transport provision of the region, the level of education in the For an urbanarea, the U elements can be:

Transport accessibility u_1;
Air pollution u_2;
Development of the social sphere u_3;
Noise level u_4;
Soil contamination u_5;
Traffic intensity on the road network u_6;
Degree of medical care u_7;

Provision of educational institutions u8
Number of recreation areas u8;
The density of industrial enterprises is 9;
Problem areas in traffic u10;
The presence of problem areas in the movement of pedestrians u11;
The presence of traffic junctions u12;
Availability of safe crossings u13;
Building density u14;
Population density u15;
District status u16 and so on.

Heterogeneous elements or characteristics create a stratified system. There is ananalogy with stratified information in GIS. Heterogeneous elements lie in different layers, but together they can amplify the impact andcause a negative or positive effect. For them, you can enter an influence function (IF) measure. The "influence function" is a complete analogue of the field function in the theory of the information field (Kudge, 2017). Therefore, the theory of the information field can be fully applied in information granular analysis.

Information granule.

An information granule is an information granular model (IGM). The IGM reflects a set of related elements. The elements of a set can generally be independently related. IGM has boundaries and two categories of elements: homogeneous and heterogeneous. Homogeneous elements define boundaries. Heterogeneous elements define commonality. IGM is physical in nature or parametric in nature. In the physical nature, an information granular model reflects a physical object, such as a cloud in the sky or a physical container. In the parametric nature, the granular information model reflects an object in parameter space, such as an information container. The IGA is a situational model and describes the situation. The more parameters there are in a situation, the more complex its visual representation and the more difficult it is for a person to analyze it. Detailed granular analysis requires the use of additional functions that describe the situation.

A distinctive feature of the granular model from other information models is its contextual structure. The contextual structure has no visual or topological representation. It is based on multiple parametric relationships. A physical granule can be an area object, a three-dimensional object, and a linear complex object. An information granule always has content.

Logical constructions in IGA.

Building a granular model or a granular situation should be based on logic. Any cause-and-effect relationship or logical chain is based on logical constructions. In the information field, logical constructions are associated with information construction (Tang et al., 2019). In logical constructions, it is necessary to distinguish between direct descriptions and contextual descriptions. Granules that use context are called "contextual" granules. Granules that use a straight, logical linear description are called "straight" granules. For straight granules, logical constructions in the language of formal logic are possible. For contextual granules, logical constructions are possible using argumentation, modal logic, natural language logic, and fuzzy set theory. Methods of logical construction have led to the concept of "logical space" (Pinkal, 1989).

In order to combine granules and connect them into a system in logical constructions, it is necessary to introduce the concept of "logical structure". In logic, the basic relation is the equivalence relation. It allows you to transform one Boolean expression into another while maintaining truth. In granular analysis, a broader and sometimes contextual relationship is used – the "correspondence relationship".

Within the framework of the correspondence relationship, logical constructions are carried out in granular analysis. A correspondence relationship allows you to move from logical formalism to natural language logic. The logical construction can be thought of as a reduction. This is due to the fact that functional and attributive aspects, as well as comparative characteristics, are excluded in logical constructions. In granular analysis, multivalued logic is also applicable due to the fact that heterogeneous variables have different qualities. The key to granular logic is the "correspondence of meaning" between the initial conditions and the granular model.

Granular information structure.

A granular information construct is a derivative of the model of an information construct. A granular information construct is a type of information model built with the use of granules.

Figure 2 shows a granular information model. It can be considered as a structure due to the fact that it has a general and conceptual appearance. Fig.2. have the following designations*:* R 1, R 2, R 3, *R4* – regions (granules), Granules G 1, common area *G2* – comfort zone (dotted line). Granule *G3 is* a zone of high contamination. Territorial zones X, Y.

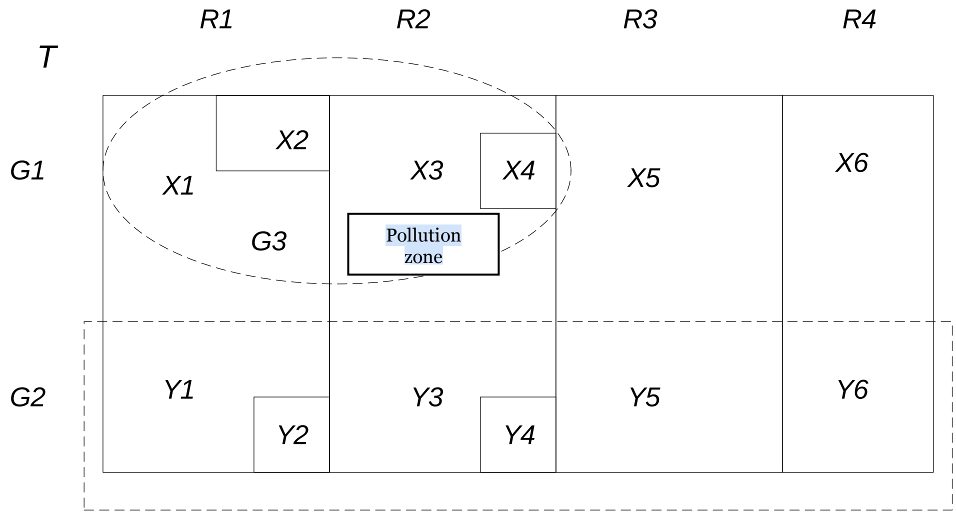

Fig. 2. Information granular structure

For the model in Figure 2, the following relationships apply.

$$R1 \cup R2 \cup R3 \cup R4 = T \quad (1)$$

In expression (1), T stands for the entire territory.

$$G1 \cup G2 = T \quad (2)$$

$$G3 \subset G1 \quad (3)$$

$$(X1, X2, X3, X4, X5, X6) \subset G1 \quad (4)$$

$$(X1, X2, X3, X4) \subset G3 \quad (5)$$

$$(Y1, Y2, Y3, Y4, Y5, Y6) \subset G2 \quad (6)$$

$$(X1, X2, Y1, Y2) \subset R1 \quad (7)$$

$$(X3, X4, Y3, Y4) \subset R2 \quad (8)$$

$$(X5, Y5) \subset R3 \quad (9)$$

$$(X6, Y6) \subset R4 \quad (10)$$

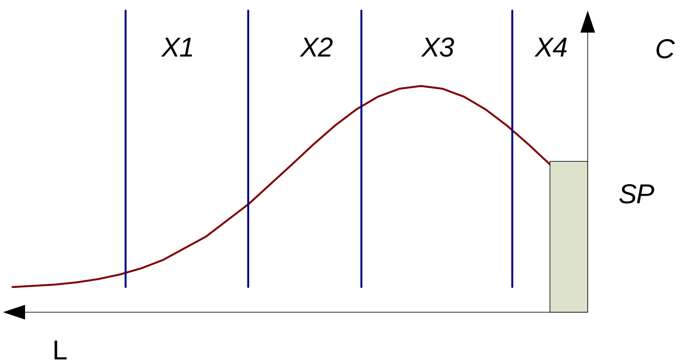

Fig. 3. Cross-section of granule *G3* according to the characteristic "ambient air pollution" (C).

Formulas (1-10) define the contextual structure of the granular model. In this example, you can see the difference between a topological structure in the form of a graph and a contextual structure in the form of relationships. The topological structure is observable by man and perceptible by man. The contextual structure is immeasurable by a human being and is perceived by a computer. The model in Figure 2 refers to the area of the information field. It is conceptual, as it describes the situation in a simplified way. Figure 3 illustrates this.

Figure 3 shows the source of SP contamination. It is usually the pipe of an industrial plant. The law of distribution of the concentration of a substance (C) is usually close to the logarithmic-normal distribution (Figure 3). Expression (5) does not distinguish between zones *(X1, X2, X3, X4)*. Figure 3 and the calculation of the function C(L) show such a difference. This example shows that the granular model does not provide comprehensive information about the situation. It allows for visual analysis. A more detailed analysis requires the use of functions that describe the situation. That is, the use of the field function of the information field.

Figure 3 shows that for this profile the place is a trend

$$C(X1) < C(X2) < C(X3) \quad (11).$$

For granules C(X2) C(X4) there is a proportionality ratio

$$C(X2) \approx C(X4) \quad (12)$$

Expressions (11) and (12) are used in decision support, for example, in solving the problem of placing a feature.

A granular information construct displays patterns and systems of relationships. A granular structure is a model Relationship systems are part of a granular model that reflects the situation of reality. A granular model is a situational model. Granular modeling can be thought of as an information field process. The purpose of granular modeling is to build a related set of parameters that describe a real situation. This combination allows for analysis and calculations.

3. Conclusion

The article introduces a new model, a granular information model. This model serves as the basis for granular information analysis. Granular information analysis is used when it is necessary to study complex heterogeneous models or sets. An example of granular analysis would be cluster analysis. An example of a granular information model would be a cognitive map. An information granule is a heterogeneous information model consisting of homogeneous models or clusters. There is a weak connection between the parts of the information granule. Physically, granules have a variable density. For example, clouds of smoke or the distribution of the concentration of harmful substances in the atmosphere. A granule has boundaries (often blurring) at qualitatively homogeneous coordinates and commonality at heterogeneous coordinates. On the example of granules Dissipation in the information or physical field can be observed.

A cloud is an example of a granule. A cloud has physical (fuzzy) boundaries and chemical composition (heterogeneous coordinates). A cloud is a three-dimensional physical granule in physical space. The information model of the cloud is the information model of the anula. A land plot is a physical areal two-dimensional granule. An information model of a land plot is an information granule. A section of railway with a right-of-way is a linear granule. An information model of a railway section is an information granule.

The information granule model is described using set theory and as an information model. An information granule has homogeneous and heterogeneous parts. An information granule can describe areal and linear objects. This increases its application in geoinformatics. In terms of content, an information granule is an information situation.

Granular analysis uses a contextual description of the structure. Such a structure has no visual form of representation. It excludes the possibility of human analysis of such a structure. The contextual structure is understood only by the computer, and this is a disadvantage of the granular approach. On the other hand, it is a method of analyzing complex structures.

A granular model is a situational model and describes a situation. The more parameters there are in a situation, the more complex its visual representation is and the more difficult it is for a person to analyze it. Detailed granular analysis requires the use of additional functions that describe the situation. These additional functions are field functions of the information field. It follows that information field theory is compatible with granular models. Information field theory helps to perform information granular analysis. The granular model makes it possible to describe complex aggregates that include different qualities. The proposed methods of granular analysis make it possible to analyze complex situations that cannot be analyzed by other methods.

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Logical Design

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Abstract

The article examines the technology of logical construction as a new direction in the construction of logical justifications and algorithms. An analysis of the logical construction introduced by B. Russell and the evolution of this concept is given. The emergence of the concept of "logic in natural language" is noted. The emergence of an evolutionary chain is highlighted: formal logic; natural language logic; logic of ontologies; logic of thought. The connecting factor in this chain is the theory of "correspondence of meaning." Consideration of the logical construct as an agent-oriented model leads to the concepts of an evolutionary and self-developing algorithm. It is noted that the concept of logic is related to logical construction and information construction. Floridi's "conceptual logic." The article proposes a new model of logical construction applied to the information field. A new term "logical information construction" has been introduced for it. The area of existence of the new model is only the information field. The logical construct is considered as a derivative model of the information construct model. The concept of "logical construction" is defined. In the development of the concept of logical information construction, the term and model "logical informational" construction have been introduced. The content of this technology is revealed. The basis of logical information construction is the "correspondence of meaning". This correspondence includes other types: informational correspondence, semantic correspondence, ontological correspondence, topological correspondence, and others. The introduced models expand the range of tasks of analysis and logical analysis.

Keywords: logic, construction, logical construction, logical constructions, computer science.

1. Introduction

Logical design is a new direction in information modeling, the construction of logical schemes and algorithms. In name, logical construction is related to logic, but it is broader than logical constructions. Logical construction uses different kinds of logics: spatial, algorithmic logic, multivalued logic, modal logic, temporal logic. In terms of content, logical construction uses information modeling. Logical design uses different types of information modeling and information models. In the process of logical construction, it is necessary to apply analysis. Logical construction uses different types of analysis: systemic, dichotomous, oppositional. Logical construction is not a formal logical technology. It uses different kinds of argumentation. Logical construction is closely related to information construction (Tang et al., 2019). In view of this, by analogy with an information construct, it is expedient to introduce the concept of logical construction. Logical construction is closely related to logical construction and defines the

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principles of logical construction. However, the term logical construction was introduced a long time ago in philosophy, logic, and the attempt to write theories. In this paper, a new interpretation of this concept is given. But for comparison, it is expedient to consider the existing concept of logical construction.

2. Discussion and results

Logical constructions in line with B. Russell's approach

The term "logical construction" was used by Bertrand Russell to describe philosophical theories. Since the 1920s, philosophers have debated the meaning of the concept of "logical construction." One interpretation considered this concept as a method in analytic philosophy (Linsky, 1996). Russell contextually defined the expressions of class entities as "incomplete symbols" and the entities themselves as "logical fictions." Russell distinguished logical constructions by explicit definition or contextual definition. Constructs that use contextual definitions are called "incomplete symbols," and constructs like class theory are called "fictions." Russell introduced the concept of "definite descriptions", with which he designated logical constructions, which he describes as "incomplete symbols". The definition of definite descriptions and indefinite descriptions was an example of the philosophical distinction between superficial grammatical form and logical form. In attempting to construct logical constructions, Russell investigated the logic of relations (Russell, 1901a; Russell, 1901b) and the logic of the philosophy of logical atomism. (Russell, 2009)

Russell's writings and ideas laid the foundations for logical construction (Sainsbury, 1980; Stebbing, 1931). These studies have led to the concept of "logical space" (Pinkal, 1989). The development of Russell's ideas led to an analysis of the concepts of "logical structure" and logical comparison (Pinkal, 1989). The concept of "natural language law" has emerged. On the one hand, it can be transformed into a logical formalism, if necessary. These are interrelated on two levels. On the other hand, it is based on semantics and semantic correspondence. The second side can be defined as content logic or correspondence logic. This enables advanced logical analysis in natural language. This makes it possible to construct logical constructions in natural language. This makes it possible to do information modeling in natural language. In this case, it is possible to use information modeling in natural language. In this case, it is important to note that this is not the case. Despite a large number of works, B. Russell has not given a clear definition of the concept of "logical construction" (Linsky, 1996).

The development of the idea of studying the relations of logical analysis and logical constructions (Linsky, 2007) led to the method of replacing all incomplete symbols in sentences with the names of possible objects of cognition. The logical construction was interpreted as part of an epistemologically motivated reduction. Consideration of logical construct as an agent-based model (Sierra-Santibanez, 2014), which studies emergence and evolution, leads to the concepts of an evolutionary and self-evolving algorithm. Further development of informal logic led to the concepts of "ontology logic" and "contingentism" (Stalnaker, 2022).

Multivalued logic and multivalued logical constructions can be noted (Miller et al., 2022). In this way, formal logic evolved into the logic of language, into the logic of ontologies, and then into the logic of thought (Gamut, 2020). The most important in this chain is the conclusion about the need for a theory of "correspondence of meaning." This is reflected in the construction of logical structures. Related to logical construction and informational construction is the concept of L. Floridi's "conceptual logic." According to his view (Floridi, 2019), that "conceptual logic focuses on formal features that do not depend on specific realizations or idiosyncratic contingencies, on types rather than lexemes, on invariants and their relationships, and on transitions between states that can be generalized». However, there is a common drawback in all the considered approaches: the failure to consider the information field and information methods in the construction of logical structures.

Logical informational construct.

In the field of the information field, a logical construction is a derivative of the model of an information structure. An information construct in the information field is defined as a conceptual model that purposefully reflects the phenomenon of reality (system, object, process, regularity) with the help of a system of interrelated, informatively defined parameters

By analogy, a "logical construct" in the information field is defined as a conceptual information model that reflects the phenomenon of explicit/implicit regularity or sequence, as well as a system of relations or connections using a system of interrelated, informationally determined logical operators and variables. The informational aspect in the description of this model gives grounds to call such a model a "logical information construction".

It should be noted that this model belongs to the field of the information field, it is expressed with the help of an information model. If the informational construct reflects the phenomenon of reality, then the logical construct reflects the patterns and systems of relations. Systems of relations are part of an informational construct that purposefully reflects the object of reality. There's a reflection aspect to that. A logical construct singles out a part of the information structure that characterizes connections, sequences, and a system of relations.

Logical construction is systematic, since it uses systems of interrelated parameters for its construction. In the information field, such systems are called systems of information units (Ozhereleva, 2014).

An information construct displays concepts and conceptual parameters. A logical construct highlights and displays sequences and patterns. That is, it has more abstraction compared to the information construct. The qualitative difference between the logical construct in the information field and the previously existing logical constructs is its representation in the information model. Such a model includes information-defined parameters. In the field of the information field, a logical construction is a logical description of a pattern or structure in the form of an information-logical model.

Logical information construction.

By analogy with information modeling, the concept of logical construction can be introduced. Logical construction allows for argumentation and cognitive logic. Based on the definition of logical information construction, logical information construction should be considered as a process of forming patterns and sequences, including algorithms.

At the same time, it is possible to use the concepts that are accepted in the process of studying logical construction: "logic in natural language", "correspondences of meaning", "conceptual logic", "logical space", logical comparison, logic of content, logic of correspondence, "logic of ontologies". You can use these concepts to organize your design. These concepts can be used to construct logical constructions in a broad sense, not just as expressions of formal logic.

Logical construction is a model Logical information construction is a process in the information field. A close analogue of logical information construction is information modeling. The purpose of logical information construction is to model or construct a logical sequence in a broad sense.

Logical information construction uses an extended interpretation of the concept of algorithm. Algorithms are used not only for calculations, but also for other purposes, such as describing patterns of behavior or reasoning. An algorithm in a broad sense can be thought of as a logical construct. Logical construction is the process of constructing sequences that includes logical reasoning. Logical information construction is an object of modeling and formation. The formed logical information construction is a procedural entity that forms a result from the initial data.

Logical information construction is used to construct a result in the form of a sequence of "logicians natural language", "conceptual logic," correspondence logic, "ontology logic."

The main thing in logical construction is the "correspondence of meaning" between the initial data and the result of the construction. As auxiliary factors, logical information construction uses "logical space", logical comparison, and cognitive logic.

"Correspondence of meaning" includes informational correspondence, semantic correspondence, ontological correspondence. In solving some problems, topological correspondence (mapping), morphological correspondence (spatial modeling) and categorical correspondence are additionally used.

This extended interpretation of the concepts of logical construction makes it possible to solve problems that cannot be solved or described by the methods of formal logic. For example, a well-known model of a cognitive map falls into the definition of a logical construct.

3. Conclusion

In this paper, logical information construction is considered not as an object of philosophy, but as a model of the information and cognitive field. A new interpretation of the term logical constructions in relation to information constructions and the information field is given. The new concept of logical construction, as a model, covers a large number of objects and helps to compare and systematize them. The new concept of logical construction allows you to create a description of patterns and sequences that have different qualities and categories. The proposed models of logical construction and logical construction make it possible to expand logical analysis in the field of information field and information technologies.

The proposed models of logical construction and logical construction make it possible to apply logical analysis to objects described by different logics: cognitive, conceptual, and multivalued.

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Information Modeling in Real Estate Management

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Abstract

The article explores the features of the application of information modeling in real estate management. The variety of application of information modeling is shown. The possibility and peculiarity of the application of building information modeling (Building information modeling) for real estate management is noted. The new concept of "digital assets" of real estate is analyzed. The content of digital real estate assets is disclosed. The features of digital asset management are described. The connection of digital assets with information modeling is shown. Information modeling is the basis for the formation of digital assets. The connection between corporate real estate management and information modeling is described. The importance of using information units for real estate management is analyzed. There is highlighted a special information that is used for real estate management. An analysis of the trend of transition from facility management to corporate management is given. The advantages of corporate governance and some disadvantages of its use in management practice are shown. It has been proven that real estate management strategies should be based on information modeling. It is proved that corporate real estate management should use information situations and situational information modeling. The article gives an analysis of the application of spatial information modeling in real estate management. Most features are areal or three-dimensional. Because of this, the use of spatial information models is an indispensable component in real estate management. There is emphasized the need for a systematic approach to real estate management.

Keywords: management, real estate management, mathematical cybernetics, information modeling, geoinformatics, digital assets, spatial modeling.

1. Введение

Информационное моделирование применяется не только в области информатики, но и во многих научных направлениях. Его применяют при моделировании возникновения коррупции (Домашук, 2015). Его применяют при формировании лесопарковых зеленых поясов (Белоконев, 2020). Информационное моделирование применяют в экологических исследованиях ландшафта (Дешко, Цветков, 2020). Информационное моделирование используют при управлении банковской деятельностью (Александров, 2015). При социологических исследованиях (Цветков, 2013a) также широко применяют информационное моделирование. В качестве современной тенденции управления недвижимостью следует отметить применение информационного моделирования зданий (Building information modeling – BIM) (Azhar, 2011). Появление BIM повлияло механизм управления недвижимостью (Bolshakov et al., 2020). Модели BIM, встроенные в

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промышленные здания, являются важной частью цифровой трансформации общества. Применение технологии BIM в управлении недвижимостью является частью цифровой трансформации общества и технологий управления. Применение технологии BIM связано с появлением Индустрии 4.0 (Ghobakhloo, 2020). Особенность BIM в том, что оно дало возможность владельцам недвижимости владеть материальными и дополнительно цифровыми активами. Междисциплинарное взаимодействие основано на информационном моделирование. В силу этого его рассматривают как универсальный метод переноса знаний (Максудова, Цветков, 2001).

2. Обсуждение и результаты

Цифровые активы как форма цифровых информационных моделей. Одной из особенностей современного управления недвижимостью является использование цифровых активов (Bolshakov et al., 2021). В данном исследовании рассматривается определение цифрового актива и рассматриваются его свойства в системе управления недвижимостью, способствующие снижению транзакционных издержек. Цифровым активом называют цифровую форму реальности и в первую очередь физических активов, которые имеют право на использование. Цифровые данные без этого права не являются активами. Цифровые активы обычно находятся в обращении и хранятся на цифровых устройствах. В работе Н. Большакова (Bolshakov et al., 2021) представлены промежуточные итоги разработки сервиса по управлению цифровыми активами. На практике показан способ учета и использования данных об объекте с применением технологий информационного моделирования. Приведена структура кода с точки зрения программирования. Предлагаемый метод направлен на регистрацию данных на протяжении всего жизненного цикла объекта капитального строительства с акцентом на стадию эксплуатации и ремонта, как на стадию жизненного цикла, наименее подверженную внедрению технологий информационного моделирования

Управление цифровыми активами (Currall, Moss, 2010) представляет самостоятельное направление. Управление цифровыми активами в любом контексте не является ни простым, ни прямолинейным и требует уровня инвестиций, незнакомого специалистам в аналоговой среде. В работе (Currall, Moss, 2010) объясняется, что при решении этой задачи как специалисты в области управления физическими активами, так и профессионалы в области информации не должны опираться на свой предыдущий опыт управления коллекциями в аналоговой форме. Необходимо знать, что цифровые технологии не представляют собой смену аналоговой формы на цифровую. Авторы (Currall, Moss, 2010) подчеркивают важность отличия оценки и отбора в цифровом пространстве от аналоговой формы. Они предостерегают от предполагаемой привлекательности того, что при такой трансформации имеет место сохранении контента. Аналоговый контент может иметь разные цифровые формы и разную модификацию содержания. Показано различие между «рожденными цифровыми» и оцифрованными объектами. Хотя все цифровые объекты могут быть сведены к битовому паттерну, каждый вид объектов имеет разные онтологические характеристики, которые, как и в аналоговом варианте, требуют разных подходов к их управлению и хранению. Управление цифровыми активами, как и любым другим активом, должно быть неотъемлемой частью стратегических целей учреждения или управления недвижимостью с соответствующим распределением ресурсов, поддерживаемым четко сформулированным экономическим обоснованием. В то же время форма цифровых активов рождается из информационных моделей трансформированных в цифровую форму.

Корпоративное управление и информационное моделирование

Еще одной особенностью управления недвижимостью является специальная информация, используемая в управлении государственной недвижимостью (Gross, Tuyet). В настоящее время информация важна во всех сферах жизни, в том числе и в сфере управления государственной недвижимостью. Мир становится все более глобализированным и используются новые технологии и системы. Общество требует иметь доступ к таким системам, которые еще несколько лет назад были доступны только чиновникам. Отсюда вытекает необходимость свободного доступа к информации. Специальная информацию о недвижимости имеет большое значение в процессах принятия решений по управлению государственной недвижимостью. Без качественной и достоверной информации нет хороших решений.

Важной особенность управления недвижимостью является тенденция перехода к корпоративному управлению недвижимостью corporate real estate (CRE) или corporate real estate management (CREM). Первый принцип корпоративного управления недвижимость есть системный (Цветков, 2018). Он требует построения модели управления и управленческих отношений на основе системного подхода и формирование модели управления недвижимостью в виде целостной системы.

Системный подход к решениям в области корпоративной недвижимости (CRE) повышает ценность компании. Решение о собственности или аренде недвижимости является важной частью стратегии организации или корпорации. Авторы работы (Krumm et al., 1998) определяют закономерности в факторах принятия решений для разных отраслей. Выявленные закономерности дадут понимание управления CRE компаний (CREM). Дана оценка корпоративных стратегий управления недвижимостью и их влияние на корпоративное развитие в городе Кампала. Использован дедуктивный подход, за которым последовало эмпирическое исследование, в ходе которого были получены качественные и количественные данные, на основе которых были сделаны выводы. Различия в том, как компании управляют своим CRE, велики. Некоторые компании имеют работающую стратегию CREM, другие разрабатывают ее, а у третьих ее нет. В целом компании склонны считать CREM более важным сегодня, чем раньше. Было выявлено несколько факторов, влияющих на решение о собственности или аренде CRE. Они кажутся специфичными для компании, а не для отрасли.

Следовательно, стратегии CREM могут быть привязаны к конкретной компании, а не к конкретной отрасли. Несмотря на отсутствие достаточных знаний и осведомленности о преимуществах стратегий CREM для корпоративных компаний, важность CREM, вероятно, возрастет в будущем из-за усиления рыночной конкуренции и глобализации. Это сделает необходимым использование CRE в качестве стратегического ресурса.

Вплоть до 1980-х корпоративное конкурентное преимущество было в основном сосредоточено на адаптации корпорации к (изменяющейся) среде. В последние десятилетия корпорации стали лучше осознавать свои ресурсы и возможности, а также преимущества управленческого внимания к управлению корпоративными активами. Переход от пассивного, реактивного отношения к проактивной организации, ориентированной на оказание услуг, оказывается трудной задачей. В работах A.L. Lindholm, K.I. Leväinen (Lindholm, Leväinen, 2006) анализируется переход и описываются усилия по выявлению продуктов и услуг, способствующих добавленной стоимости корпоративного управления недвижимостью в чистую прибыль корпорации.

Стратегии, основанная на информационном управлении и моделировании, в сфере недвижимости могут повысить ценность основного бизнеса, предоставив управляющим корпоративной недвижимостью инструмент, иллюстрирующий руководителям корпораций, как недвижимость увеличивает стоимость фирм.

В работах A.L. Lindholm, K.I. Leväinen (Lindholm, Leväinen, 2006) показано, что многие фирмы не осознают, как недвижимость увеличивает стоимость бизнеса. Хотя у них может быть корпоративная стратегия в сфере недвижимости, эта стратегия часто не согласуется с общей бизнес-стратегией. Кроме того, показатели эффективности, используемые многими компаниями, сосредоточены исключительно на затратах, а не на добавленной стоимости. Для устранения этого недостатка авторы (Lindholm, Leväinen, 2006) предлагают свою систему определения и измерения добавленной стоимости корпоративной недвижимости. Система использует информационные модели и моделирование.

Основной альтернативой корпоративного управления недвижимостью является управление отдельными объектами недвижимости. Более четко это различие заключается в теории управления объектами (facilities management – FM) и корпоративном управлении (corporate real estate management CREM).

Общим для обоих направлений является использование специальной информации и информационного моделирования, но существенно разной степени. Для управления объектами используются информационные модели объектов, которые являются относительно простыми. Для корпоративного управления используются информационные модели систем объектов, модели информационных ситуаций (Цветков, 2016), модели динамики ситуаций и динамики в ситуациях. Эти различия можно назвать информационными.

В экономическом плане FM, и CREM нацелены на поддержку основных бизнес-процессов путем согласования физических ресурсов организаций с организационными стратегиями, чтобы способствовать повышению эффективности организации и повышению ее ценности. Эффективная и действенная поддержка основной деятельности и бизнес-целей является ключевым вопросом. Различия учитывают фокус на объектах и услугах (FM) по сравнению с портфелями зданий и недвижимости (CREM), а также более короткие временные рамки и высокую гибкость объектов (FM) по сравнению с длительным жизненным циклом и довольно статичными зданиями (CREM). Несмотря на различия, ожидается (Lindholm, Leväinen, 2006), что в будущем обе дисциплины будут более интегрированы на основе информационного моделирования и унифицированных информационных моделей. Такими унифицированными моделями в настоящее время являются информационные единицы, которые в сфере недвижимости пока используют слабо. Есть основание ввести термин «информационные единицы недвижимости» для более эффективного применения информационных технологий в сфере недвижимости.

Пространственное информационное моделирование при управлении недвижимостью.

Объекты недвижимости представляют собой пространственные ареальные или объемные объекты. Для моделирования таких объектов применяют методы геоинформатики и геоинформационное моделирование (Цветков, 1999). Важным принципом геоинформационного моделирования и управления недвижимостью является принцип эквифинальности, который заключается в необходимости идентифицировать различные элементы недвижимости. Эквифинальность в большом приводит к построению информационной модели объекта недвижимости и к описанию ее состояния, которым впоследствии можно управлять. Целостность объекта недвижимости дает основание строить его модель как целостную систему. Эквифинальность в малом приводит к использованию геоданных (Розенберг, 2020) и построению на их основе информационных единиц (Болбаков, 2014; Цветков, 2014a). Если объект недвижимости рассматривать как систему, то информационные единицы являются элементами такой системы.

Важным фактором, влияющим на стоимость объекта недвижимости, отмеченным еще в 1828 году Иоганном фон Тюненым, являются пространственные отношения, которые чаще всего связаны с расстоянием и расположением относительно некого центра. Например, для Москвы характерно возрастание стоимости недвижимости по мере приближения к центру города и падение стоимости по мере удаления от него. Следовательно, необходимо учитывать пространственные отношения (Цветков, 2013b; Бахарева, 2018) при оценке стоимости недвижимости и при управлении ею, например при решении задач размещения.

Управление недвижимостью, особенно в городах, характеризуется изменчивостью ситуаций, в которых необходимо проводить информационное моделирование и управление. моделирования. Это необходимость использования ситуационного анализа и ситуационного моделирования при управлении недвижимостью. При использовании геоданных и геоинформатики это приводит к необходимости применения ситуационного геоинформационного моделирования (Бучкин, Потапов, 2020; Цветков, 2014b). Общим принципом применения пространственного информационного моделирования при управлении недвижимостью является устойчивость состояния объекта недвижимости (Lai, 2006) и устойчивость его развития (Nosratabadi et al., 2019). Управление недвижимостью и строительством посредство информационного моделирования и BIM позволяет решать проблемы, связанные с устойчивым развитием. Информационное моделирование представляет собой основной механизм, который может позволить более тесно увязать экологические и социальные задачи с экономической отдачей

3. Заключение

Информационное моделирование при управлении недвижимостью позволяет решать технические задачи управления. Экономические задачи оценки и социальные задачи управления недвижимостью. Оно интегрирует технологии при управлении недвижимостью. Поэтому оно служит основой инновационного (Розенберг и др., 2010) и инвестиционного (Lützkendorf, Lorenz, 2005) управления недвижимостью с целью обеспечения ее устойчивости. Вклад корпоративной недвижимости в достижение основной цели максимизации благосостояния можно смоделировать, чтобы проиллюстрировать материальные и нематериальные эффекты, которые недвижимость оказывает на финансовые показатели. Структурированный подход к разработке стратегии в области недвижимости в сочетании со стратегией основного бизнеса, поддерживаемый системой измерения эффективности, позволит руководителям корпоративной недвижимости лучше сообщать о том, как корпоративная недвижимость повышает ценность фирмы. Корпоративным менеджерам по недвижимости нужны лучшие способы проиллюстрировать корпоративным лидерам, как они добавляют ценность. Эта статья иллюстрирует такую модель с вспомогательными операционными решениями и показателями эффективности. Информационное моделирование в FM и CREM может быть использовано для улучшения технологий и теории управления недвижимостью. Корпоративная стратегия управления недвижимостью должна быть согласована с общей бизнес-стратегией.

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Информационное моделирование при управлении недвижимостью

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Аннотация. Статья исследует особенности применения информационного моделирования при управлении недвижимостью. Показано разнообразие применения информационного моделирования. Отмечена возможность и особенность применения информационного моделирования зданий (Building information modeling) для управления недвижимостью. Анализируется новое понятие «цифровые активы» недвижимости. Раскрывается содержание цифровых активов недвижимости. Описаны особенности управления цифровыми активами. Показана связь цифровых активов с информационным моделированием. Информационное моделирование является основой образования цифровых активов. Описана связь корпоративного управление недвижимостью с информационным моделированием. Анализируется важность применения информационных единиц для управления недвижимостью. Выделена специальная информация, которую применяют для управления недвижимостью. Дается анализ тенденции перехода от управления объектами к корпоративному управлению. Показаны преимущества корпоративного управления и отдельные недостатки его использования в практике управления. Доказано, что стратегии управления недвижимостью должны строиться на информационном моделировании. Доказано, что корпоративное управление недвижимостью должно использовать информационные ситуации и ситуационно информационное моделирование. Статья дает анализ применения пространственного информационного моделирования при управлении недвижимостью. Большинство пространственных объектов являются ареальными или трехмерными. В силу этого применение пространственных информационных моделей является обязательным компонентом при управлении недвижимостью. Подчеркнута необходимость применения системного подхода в управлении недвижимостью.

Ключевые слова: управление, управление недвижимостью, математическая кибернетика, информационное моделирование, геоинформатика, цифровые активы, пространственное моделирование.

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