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Data Ontology

A textbook on the academic discipline "Philosophy and Methodology of Science"
for master's students of all specialties

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The textbook will allow students to study in depth topics related to the philosophy of consciousness, philosophy of artificial intelligence, philosophy of technology, social philosophy, ethics and philosophy of digital law.

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INTRODUCTION

The term "ontology" was used for a long time only in philosophy to denote one of the fundamental sections of metaphysics. The task of this section included a conceptual description of the objective reality external to man, with which nature and the social space of his life activity within the Earth created by mankind were associated. A categorical apparatus was developed for the tasks of ontology.

It included the concepts of being, existence, essence, substance, matter, space and time, movement and development, chaos and order. Ontology sought a systematic description of being as a single space. This was typical for Plato, Aristotle and Hegel. The questions that arose detailed the conceptual apparatus of ontology with additional categorical structures. Since philosophy was represented by different general ontologies, it began to be criticized for the lack of connection between these general ontologies and practical tasks.

There were historical periods when philosophy itself lost interest in ontological topics. M. Heidegger tried to revive the status of a general philosophical ontology. At the stage of formation of discipline-organized science, there was a need for a general ontology of scientific knowledge and a subject ontology of scientific knowledge. At first, subject ontologies of specific sciences were actively developing. This was evident in astronomy, biology, geography, geology, physics and chemistry. Then T. Kuhn and I. Lakatos updated the concept of general ontology in science. It is expressed by the terms "paradigm" and "research program".

V.S. Stepin proposed the term "scientific picture of the world". Ontology saw practical use by the end of the 20th century, when it turned out to be in demand in artificial intelligence technologies at the stage of data processing, as well as in machine learning.

This practical perspective updated another topic of ontology related to the semantic consideration of human consciousness. I. Kant, F. Brentano and analytical philosophy played an important role in this consideration. Knowledge of the features of the ontology of human consciousness is necessary for the development of artificial intelligence technologies and human-machine systems.

Why do we need ontology?

Ontology is needed for epistemology as a general categorical structure, which is used in the form of subject modifications in the conceptual apparatus of specific sciences. Among these general categories are matter, energy, movement, space, time, interaction. The list is not limited to the named categories. The conceptual apparatus of general ontology is used in specific sciences in the construction of theoretical knowledge that undergoes empirical testing by scientific observations, experimental research and measurements.

Ontology is needed for epistemology, since it develops concepts for the systematization of knowledge. Among these concepts are the concepts of paradigm, research program, scientific picture of the world, theory and model.

Ontology is needed by ontology itself as a dynamic ontology of the objective reality of nature in the unity of definitions of actual and potential being, dynamic equilibrium and dynamic diversity, self-organization, development and evolution, phase transitions. Ontology recommends considering being in the categories of linear and nonlinear dynamics of reality.

Ontology is needed to study dangers and risks. Thus, the history of the existence of the biosphere within the Earth contains, according to archeology and paleontology, examples of catastrophes and mass deaths of living organisms. This means that the dynamic equilibrium of the dynamic diversity of the biosphere depends on various objective and subjective factors of dynamics.

Ontology is in demand in modifying the dynamic ontology of being, which is due to the human factor, focused on the categories of development, progress and growth economy. In this context, the concepts of modernization, scientific and technological progress, scientific and technological revolution, industrial revolution and technological structure are actively used. Ontology plays an important role in people's worldview. It forms people's systemic vision of the universe through the conceptual apparatus of cultural universals.

Ontology is in demand in knowledge representation tasks. It develops tools adapted for use in computer systems for solving applied problems. These tools include the construction of formalisms that simplify work with complex systems. Types of formalisms are semantic networks, system architecture, rules and ontologies proper.

Ontology contains a method of formalizing knowledge in a subject area, implemented by a formal description of objects, facts and relationships between them. A conceptual scheme is used for formalization. It is represented by a semantic network of concepts and notions interconnected according to certain rules. The scheme consists of a data structure containing all relevant classes of objects, their relationships and rules (theorems and constraints) adopted in a given subject area. In this form, the methodological construction is used in the status of a subject ontology. Ontologies are based on mathematical formalisms of description logics.

They operate with the concepts of "concept" and "role". Such a methodology is especially characteristic of ontologies for solving specific problems in a specific subject area. Its use is relevant for computer science.

Ontologies in computer science are assessed by the criterion of applicability, not completeness. In each science, ontologies are created to organize data in the form of information and knowledge. General components of a subject ontology include objects, concepts, attributes, relations, rules, axioms and events. Ontologies are encoded in specialized formal languages and form the semantics of artificial intelligence technologies.

The semantic web creates conditions for machine processing of information, for its adequate analysis, synthesis of conclusions, data transformation and conclusions obtained on their basis. Linguistic, logical and statistical algorithms are used. The presence of a basic ontology of the subject area plays an important role. An independent ontology, a statistical model formed by experts from a specific subject area can be a standard. In this way, a structural specification of a certain subject area is created, its formalized representation, which includes a dictionary of point-

ers to terms of the subject area and logical expressions that describe how they relate to each other.

Ontologies are used as an intermediary between the user and the information system, they allow formalizing agreements on terminology, for example, between users of a corporate data warehouse. Ontologies integrate information. They define the formal semantics of information, allowing this information to be processed by artificial intelligence. They also define the semantics of objective reality, allowing, on the basis of common terminology, to link information presented in the form required for computer processing with information presented in a form convenient for human perception.

The question of why ontology is needed is related to the question of what are the goals of creating ontology. One of the goals of creating ontology is for people and software agents to use a common understanding of the structure of information. Another goal of developing ontology is to create a model of the subject area. Another goal of developing ontology is to analyze the system of concepts and the relationships between them. One of the goals of ontology is to ensure machine readability of data.

A. Turing linked the meaning of textual information with the problem of probability, which can be described mathematically through statistics. He replaced information with its statistical form, and replaced the thinking process with a procedure for calculating the results of correct and incorrect answers.

The structure of ontology

The semantics of ontology is formed by concepts, relations, axioms, and individual instances. Concepts are considered as conceptualizations of a class of all representatives of a certain entity or phenomenon. Classes (or concepts) are general categories that can be ordered hierarchically.

Each class describes a group of individual entities that are united on the basis of having common properties. Concepts can be linked by various kinds of relations that bind classes together and describe them.

Axioms set the conditions for correlating categories and relations; they express obvious statements that link concepts and relations. Instances are individual representatives of a class of entities or phenomena, that is, specific elements of a category. The components of an ontology are subject to hierarchy. At the lower level are instances, specific individuals, and above them are concepts, that is, categories. The relations between these concepts are located at the level above, and the generalizing and connecting level is the level of rules or axioms. Slots (parameters) describe the properties of classes and instances.

At the formal level, ontology is a system consisting of sets of concepts and statements about these concepts, on the basis of which classes, objects, relations, functions, and theories are built. Ontological systems are built on the basis of formalization principles, descriptions of objective elements of reality in uniform, strictly defined terms and models; using a limited number of basic terms (entities) on the basis of which all other concepts are constructed; internal completeness and logical consistency.

According to the degree of dependence on a specific task or subject area, there are top-level ontologies. They describe the most general concepts that are independent of a specific problem or area. These are general concepts that can be used by a wide variety of software tools. These are domain-oriented concepts. They can be used by domain experts to share and annotate information in their area. These are task-oriented ontologies. They are used by a specific application program and contain terms that are used in the development of application software.

Application ontologies describe concepts that depend on both task ontology and domain ontology, for example, an ontology for computing.

General ontology in modifications of cultural universals and categories of philosophy

General ontology contains in its structure a set of concepts describing the framework of being with a description of the essence of being as a dynamic reality, which after actualization in the form of self-organization or divine creation, ac-

quired the functions of dynamic equilibrium. The first historical modification of general ontology was the system of cultural universals. This conceptual system presents all the basic concepts that philosophy, science and computer science subsequently began to use.

People of different cultures identified the universals of chaos and order, space and time, deities, sensory reality and the afterlife. Dialogue with the gods played a key role in the lives of people of different cultures, since it was believed that the gods and the single incorporeal God in monotheism were the architects of the universe. Over the course of many centuries, humanity has developed categories of common sense, which have become the ontological basis of human experience. Categories of common sense have become the subject of study in the philosophy of British empiricism and in pragmatism. This can be seen in the works of C. Peirce and James.

The general ontology of philosophy uses the same categorical apparatus as the structures of common sense, with the only exception being that the categories of philosophy in the modification of rationalism allow going beyond the boundaries of common sense into the sphere of speculative reflections that have no direct connection with experience.

This is explained by the fact that the general ontology in the form of cultural universals was aimed at ensuring the spiritual and mental balance of the consciousness of people of different historical eras.

This was a question of the systemic security of people in the conditions of constant dangers, risks and natural threats.

Without knowledge of the general ontology of a specific historical culture, it is impossible to read the meanings contained in rock and cave paintings. This is shown by field studies of archaeologists.

Why does philosophy need general ontology?

It is believed that philosophy operates with a general ontology. This ontology began to be developed by philosophers on the basis of cultural universals. The

list of universals was supplemented by the categories of being, substance, essence, matter, idea, number, atom, apeiron, opposition and chaos.

Philosophers within the subject field of ontology tried to describe the origin of the actual dynamic diversity of nature. They had difficulty accepting the idea that this dynamic diversity is the result of the self-organization of matter, since they could not recognize the existence of the function of reason in nature. They believed that this function has its own ontological immaterial basis.

Those philosophers who recognized the function of self-organization for matter began to represent the positions of materialism (Thales, Anaximander, Anaximenes, Heraclitus, Leucippus, Democritus). Those philosophers who believed that the bearer of the function of reason is an independent immaterial entity began to represent objective idealism (Pythagoras, Plato, Aristotle).

Above these differences rises the pure ontology of Parmenides, which considers actual being to be eternal and unchangeable. He is not interested in the topic of the building material of actual being. The basic assertion is that being exists, and non-being does not. K. Ptolemy's geocentric system of the universe became a clear demonstration of the general ontology of ancient philosophy.

But there was also a dynamic general ontology, in which the question of the prime mover that created the universe remained unresolved. This question was formulated by Aristotle. The Neoplatonists brought it as close as possible to the monotheistic cultural tradition of the Mediterranean, represented by Christianity. God began to be considered the prime mover. He also began to be viewed as the creator of the universe and man.

In the Renaissance, philosophy became secular and focused on the scientific methodology of research. N. Copernicus and G. Galileo laid the foundation for the development of a general ontology of nature within the boundaries of philosophy, based on strict criteria of scientific research related to the principles of clarity, accuracy, evidence, consistency and experimental validity.

The criteria of clarity and accuracy contributed to the development of the mathematical apparatus of algebra and analytical geometry. Special terminological

apparatuses were developed in the subject areas of physics and chemistry. On their basis, conceptual structures of mechanics, optics, thermodynamics, atomic physics and space physics were formed. But the optimism generated by the discoveries of empirical and theoretical science was overshadowed by the discussion about the nature of nebulae, in which I. Kant participated.

As a result, the general ontology of the universe external to human consciousness lost its status in classical philosophy. Hegel tried to restore its status on the basis of the categorical structures of objective and subjective dialectical logic. Objective dynamic ontology has no relation to physical nature in Hegel. This dynamic ontology is a description of the self-actualization of the absolute idea through the stages of being, formation and existence.

In the book "The Science of Logic" Hegel describes the dynamic diversity of existence through the categories of contradiction, identity, difference and opposition. He describes the mechanism of the dynamic diversity of existence through the categories of quantity, quality and measure. He describes the dynamics of existence as a cumulative process through the categories of "continuity", "negation" and "negation of negation".

K. Marx and F. Engels extended the categorical structures of Hegel's general objective dialectical ontology to physical nature and the social space of human activity. As a result, the general ontology returned to the subject of physical nature. It took the position of materialism and recognition of the self-development of physical nature through evolution. The influence of the evolutionary theory of C. Darwin was felt. But when Marxists returned the general ontology to the subject of physical nature and materialism, they found themselves faced with the question of the need to explain the latest discoveries in physics. These discoveries touched upon the fundamental question of the initial building material of physical nature.

V. I. Lenin translated this question into the format of the epistemological subject of philosophy. He defined matter in the epistemological format as a category that denotes an objective reality that exists independently of human consciousness, which is copied, photographed and displayed by his sensations, existing in-

dependently of them. This emphasis showed that the general ontology of philosophy is interested only in the fact of the objective existence of physical nature, and the study of its specific structure becomes the prerogative of the natural sciences. Also, the role of categorical structures of dialectical logic, borrowed from Hegel's philosophy, was preserved in the structure of the general ontology.

As a result, the general ontology of physical natural reality settled on the thesis that the natural sciences will have to study the structure of objective natural structures at the level of elementary particle physics. Under the influence of the theory of corpuscular-wave dualism, physics came to the conclusion that the initial building material of the universe can simultaneously have a corpuscular and wave nature. This understanding of the general ontology of physical reality led to the development of string theory and superstring theory, which must undergo empirical substantiation.

The question of the dynamic systemic characteristics of the Universe remains open. The ontology of these dynamic systemic characteristics is formed by Friedman's mathematical models with scenarios of unlimited expansion of the Universe and its possible return to the original state of a singular point. Data on the critical values of the mass of dark matter and dark energy are used as criteria for choosing one of the models. But these data require careful verification.

With regard to the physical universe, the thesis on the role of matter (particles) and antimatter (antiparticles) in its dynamic equilibrium is used. With an equal ratio of matter and antimatter, annihilation ensures the initial dynamic equilibrium of the physical universe, provided that it is homogeneous.

But, as the Big Bang showed, the physical universe is not a homogeneous medium. As a result, points of release of energy-saturated matter or energy-saturated antimatter are formed in its topology, which are transformed into an environment of dynamic chaos with a tendency for self-organization of physical systems with the potential for dynamic diversity within the dynamic equilibrium of the physical universe. In this context, it is important to distinguish between the

physical universe and physical systems (metagalaxies) generated by the nonlinear architecture of singular points.

In the active dynamic state of the physical universe, the key role is played by the characteristics of the material environment of space in the form of a field that generates object structures based on gravitational, electromagnetic and nuclear interactions. The material environment of physical space has the systemic properties of a quantum field. Based on this understanding, it can be argued that object structures are modifications of the material environment of physical space according to the parameters of specific density, mass and energy processes.

All these conceptual descriptions require specification in the subject areas of the natural sciences, which is what these sciences do. The subject of general ontology, in addition to nature, is the potential physical being actualized by human creativity, which does not have self-organization functions. Subsystems of social being created by humanity on Earth belong to the varieties of such physical material being. These subsystems include the agricultural environment, technology and technology, and the urban environment. Since these ontologies are located within the Earth in the biosphere space, they have local systemic features of joint evolution. The range of tolerance plays an important role in their interaction.

General philosophical ontology as a tool of epistemology

Ontology is on the one hand treated as an independent section of philosophy, on the other hand, in fact, it is an auxiliary section of epistemology, since in this section ontology is used as a categorical structure containing initial concepts, on the basis of which the specification of conceptualization to a specific subject topic of data and the solution of a specific problem related to data occurs. A similar perspective of general ontology followed from the philosophical system of I. Kant of the critical period. According to this philosophical system, the cognizing subject does not have access to external physical reality in its material form.

The cognizing subject has access only to how things appear to his individual consciousness. Therefore, I. Kant understood general ontology as a system of cate-

gories of reason. They ensure the synthetic unity of apperception. Ontology contains a priori conditions and the first principles of any knowledge. As a result, man with his cognitive capacity must be in agreement with the a priori structures of transcendence. The possibility of synthetic judgments a priori depends on this agreement. This is the initial condition under which the content of contemplation can be reduced to the unity of apperception.

Contemplation is associated with the influence of external objects; therefore, it is sensory. Space and time are forms of contemplation of phenomena of objects of sensory cognition. Time is a formal condition a priori of all phenomena. It is a condition of the possibility of contemplating all phenomena of external and internal experience. As a result, the transcendental aesthetics of I. Kant contains a priori conditions that allow the application of the ontological system of concepts of reason to objects of possible experience. This is an example of the ontological interpretation of sensory cognition.

The system of categories of reason was formulated by I. Kant in transcendental logic, which performs the function of ontology. Transcendental logic describes the origin of pure categories of reason and establishes the way in which the data of experience are brought under these categories. Categories are universal ontological predicates and represent forms of unity for the synthesis of the content of pure contemplation and forms of unity of the synthesis of time.

The application of pure rational categories to the phenomena of experience is associated with the concept of the transcendental definition of time, which I. Kant calls the scheme of subsuming phenomena under categories. In this way, he designates the ability to synthetically elevate empirical phenomena and pure rational categories into the image of a single knowledge.

The goal of I. Kant's critical philosophy is not the construction of a theory of knowledge, but the study of the conditions of the possibility of ontology. Time is recognized as the determining basis of the relationship to reality. I. Kant considered the idea of knowledge a priori only in relation to objects of sensory contem-

plation. E. Husserl expanded the area of a priori knowledge and introduced the concept of categorical contemplation.

As a result, the relationship between logic and ontology began to be considered. Formal logic relied on the idea of cognition through reason alone. Within the framework of such logic, the concept of being was presented as empty thinking and empty contemplation. In phenomenological transcendental logic, a requirement arises to build an ontology based on the idea of the original contemplation. This task is formulated in the fundamental ontology of "Being and Time" by M. Heidegger.

Dynamic ontology in the modification of Indian philosophy

Among the first to develop a general dynamic ontology were Indian thinkers. Dharma plays a special role in dynamic ontology.

Dharma is one of the main concepts of Buddhist philosophy. The doctrine of dharmas originated in the Sarvastivadin school. The Vaibhashikas claim that dharmas really exist and exist in three times. Reality contains an unceasing flow of dharmas. They are simple, indivisible and instantaneous. One dharma exists only for a moment, then a new dharma appears. Reality manifests as the instantaneous existence of dharmas. Each dharma has only one specific attribute and is not a substance, since a substance is a carrier of many qualities. Substance is eternal, and dharma is instantaneous.

Followers of the sutras claimed that only the dharmas of the present really exist. Nagarjuna, the founder of the Madhyamika school, believed that dharmas are empty, have no essence and support. The only attribute that unites them is the absence of an attribute. In this position, dharma is emptiness. It has no attributes. The theory of dharmas of the Yogacara school is associated with the teachings of the Sarvastivadins and is based on criticism of atomism and on the denial of the existence of dharmas outside of consciousness.

In Hinayana (Vaibhashika, Sautrantika), the idea of the real existence of dharmas as certain elements of reality is formulated. Representatives of the Maha-

yana schools (Madhyamika and Yogachara) emphasize the relativity of dharmas, their emptiness and come to the conclusion that all dharmas are the dharmas of Buddha. Closely related to the doctrine of dharmas is the doctrine of instantaneity, according to which existence is divided into a sequence of separate, instantaneous dharmas. Dharmas disappear immediately after their emergence.

Thus, a stream of interdependent phenomena is formed. According to this theory, being is instantaneous, changeable and impermanent. Dharmas are points in space and time. The element of being is identical to the moment and instant. The elements of being are disunited, since they are not connected by any single substance. They disappear. They are replaced by new dharmas.

The rapid alternation of dharmas creates the illusion of immutability and duration. At each moment in time, the world and all the creatures living in it are different from the previous moment. A person cannot see these instantaneous changes due to the fact that these changes occur at the microscopic level of dharmas.

The theory of variability is also characteristic of other Indian philosophical schools, such as Vaisheshika, Yoga, but only in Buddhist philosophy does it lead to the theory of instantaneity. Recognition of the replacement of one essence of dharma by another is a denial of any lasting substance.

Likewise, there is nothing constant and unchanging in man. Variability is inherent in the inner nature of both human beings and all phenomena of the world. It is variability that gives rise to a deep feeling of dissatisfaction in living beings. An individual constantly experiences emergence and death during his existence. Sam-sara means not only and not so much the cycle of rebirths. It means birth and death. They occur every moment. Awareness of this essence is one of the steps to liberation and true reality. This is the essence of nirvana.

The Buddhist philosophy of eternal becoming consists of the theory of mutually dependent origination. It consists of the doctrine of dharmas as elementary particles of being and the doctrine of instantaneity, postulating the variability of being. Reality is presented as a process of a beginningless flow of becoming.

At the same time, dharma denotes the natural and social order. Dharma is defined as a combination of utility and Vedic religious prescriptions.

The source of the correct understanding of the essence of dharma for the Brahmin caste are the Vedas.

The philosophical school of Sankhya developed the concept of purusha. It linked the category of purusha with the material principle of prakriti.

In the philosophical school of "Vaisheshika", an important role was given to ontology and such categories as the fundamental principle, the substance of being, inherence, the general and the particular.

The dynamics of being are formed according to the laws of karma, forming a transition from non-being to physical being.

As a result, a variety of things arise in space and time, connecting, in different proportions, the elements of earth, water, fire and air. The universe develops cyclically, arises and disappears, in order to be reborn again.

Dynamic ontology in the modification of Chinese philosophy

The philosophical schools of Ancient China rely on the Pentateuch and the Tetratuch. The Pentateuch consists of the Book of Changes, which describes the basic principles of cosmology and natural philosophy. Chaos is one of the most complex and multifaceted concepts of Taoist philosophy.

First of all, it denotes the most important stage of cosmogenesis, in which all things are merged into a mysterious unity and are not yet separated, and in this sense it acts as a synonym for Tao. The main function of chaos is the generation of beings. Taoist philosophers adhered to the idea of the emergence of the world of things as a result of the self-development of the original chaos. The Daodejing uses metaphors that emphasize the generative nature of chaos.

Although the metaphors do not reveal what the original chaos is, they point to its main purpose of generating things. Being the root cause of the world and the source of ten thousand things, chaos evokes a feeling of respect and admiration in

everything that exists. The most important aspect of the original chaos is its proximity to naturalness, which becomes the cornerstone of Taoist philosophy.

The idea of chaos as the embodiment of naturalness is manifested in such features as formlessness and integrity, all-encompassingness and all-pervasiveness, as well as following non-action. Formlessness as the main feature of the original state of the Universe is borrowed by the Taoist tradition from cosmogonic myths about the emergence of the world as a result of the division of the original unity into opposite principles. Initially, the world was an undifferentiated chaos in which there was no division into opposites.

The idea of the formlessness of chaos received its greatest development in the philosophy of Zhuangzi. In chaos, the whole world is one, there is nothing that chaos would not include and could perceive outside itself. This is the state of harmony. The absence of opposition between the perceivers and the perceived creates an ideal original unity. From formlessness as a distinctive feature of the original chaos comes the idea of the infinity of its manifestations.

In Taoist texts, formlessness, all-encompassingness and infinity are closely related features that distinguish chaos from formed things, and accordingly endowed with limited and knowable features.

Chaos is an all-encompassing principle, there is nothing that it does not include, just as there is nothing that it would not create. From the infinity and all-pervasiveness of chaos, a conclusion is made about its incomprehensibility by the senses and the mind. Despite the fact that the manifestation of chaos (De) is present in every thing, it is impossible to see the image of the unity itself, man submits to it, but does not recognize its presence in the world.

Man's knowledge of chaos is purely intuitive, such knowledge cannot be accurately conveyed in words, and any attempt to explain the nature of the original unity only takes people further from the truth. Zhuangzi continues this idea of Laozi and emphasizes that in order to know the original unity, one cannot rely on studying any books. Another significant feature of the original chaos, which makes it the embodiment of naturalness, is its inactivity and passivity.

Even in its existence and the process of generating the world, chaos does not violate the natural order, since it adheres to non-action.

The embodiment of this quality of the original chaos is water. Such a metaphor appears in the Daodejing to once again emphasize the ability of the original chaos to generate existence, as well as to indicate a specific way of influencing through compliance and non-action.

Chaos serves not only as the beginning of the Universe, but also as the end point of further development of various things formed as a result of cosmogenesis. The return to the mysterious and unknowable root cause of the world reflects the natural desire of all things and the fulfillment of the purpose of human life.

It becomes possible due to the fact that, although the world of things seems diverse and everything in it is endowed with individual characteristics, the true nature of the world is integrity, conditioned by the presence of the original chaos in each thing. In the process of cosmogenesis, each thing receives something from the original chaos and retains it throughout its existence.

Chaos gives all things individual properties, distinguishing them from the original unity. De transfers some properties of the original chaos to all elements of the formed universe. Due to the presence of De, all things are as they are, but at the same time they are all part of the whole. It is De that gives things a vector of development and provides them with the opportunity to return to the source of being.

The formed world is a world of existing oppositions in the format of integrity. All things develop from one feature to the opposite feature. The ability to see the world in the unity of the changes occurring to it, and the universality of the laws of the universe become an integral quality of the observer.

True knowledge of the world lies beyond the boundaries of differences between oppositions. Instead of paying attention to differences, the wise sees in any thing the unity of sometimes contradictory properties. The sage not only sees disparate things as whole, but also perceives himself as part of this whole.

Dynamic ontology in the modification of European philosophy

In ancient Greek philosophy and poetry, chaos is a pre-cosmic state of being. The concept of chaos was first used by the Greek philosopher Hesiod. In ancient philosophy, chaos was often associated with disorder and lack of form. For the ancient Greeks, it represented the original state of the universe, from which divine forces then emerged, giving the world order.

Chaos began to be viewed as the original matter from which the world arises. Medieval philosophers often viewed disorder as a state of mind before the creation of divine order. A little later, during the Renaissance, it began to be interpreted as a principle of creativity and the possibility of creating new forms.

Ancient chaos is most often understood as the primary state of the world, a disordered space that gives rise to all living things, a certain principle of formation. This general concept does not imply semantic unity in the interpretation of the concept of chaos by ancient thinkers. Heraclitus associated this concept with the cosmos. He argued that the world is constantly in a state of change and chaos plays an important role in this process. According to his teaching, chaos and order are interdependent.

The theory of self-organization describes the emergence of order from chaos through the influence of control parameters. In this case, the influence of control parameters is related in a certain way to uncontrolled fluctuations of the elements of the system. This explains the difficulties of managing the development of a system whose state depends on the interaction of a large number of elements.

The goal is to study the synergetic pattern of self-organization in nature, society and thinking. The process of self-organization is described as the emergence of order from chaos under the influence of control parameters. Boundary conditions can serve as a control parameter. This allows external factors to control the state of the system. A variety of order parameters can give rise to chaos.

There is a competitive struggle between the set of order parameters, during which one of the order parameters can win, which will determine the features of the functioning of the system based on the principle of subordination.

Synergetics is considered as a theory of systems development, which allows explaining the emergence of emergent properties of the system. Synergetics studies the patterns of complex self-developing systems. Idealization of a nonlinear environment is a key construct of synergetics. This construct is used in self-organization models of many sciences, but this construct has its own boundaries.

General ontology of the dynamic equilibrium of being

Thales of Miletus built ontology of the dynamic equilibrium of a system based on materialism. He considered water to be the basic substance of the universe. Anaximander of Miletus considered apeiron to be the primary basis of being. Anaximenes of Miletus considered air to be the primary substance of the universe. Heraclitus of Ephesus considered fire to be the primary basis of being. Fire sets the universe in motion. Therefore, the universe is characterized by high dynamics. You cannot step into the same river twice. This is one of the early examples of objective dialectics.

Leucippus and Democritus created the doctrine of atoms and emptiness. Atoms are invisible indivisible particles, the combination of which in different quantities, qualities and proportions forms material reality. Epicurus supplemented this teaching with the assertion of a deviating atom. In his opinion, initially all atoms fell from top to bottom evenly and in a straight line, then one of them accidentally deviated and collided with neighboring atoms.

As a result, the cosmos was formed from the resulting chaos in the form of an order of objects. The Roman philosopher Titus Lucretius Carus wrote a poem about atoms in Latin called "De rerum natura" ("On the nature of things"). Pythagoras saw an immaterial digital principle at the basis of the universe. He is the founder of objective idealism. Parmenides from the Eleatic philosophical school studied the problem of the relationship between being and non-being.

Zeno of Elea formulated the aporias "Achilles and the Tortoise", "Stadium", "Dichotomy" and "Arrow". Aporias, despite their formal logical correctness, contradict the observed facts. Zeno of Elea is also credited with the "Liar's Paradox".

Empedocles, who represented Italian philosophy, considered the physical world to be the result of the mixing of the primary elements of earth, water, fire and air under the influence of opposing forces. Anaxagoras considered "homeomerics" ("ὁμοιομερεια") as the primary basis of being. They contain the four elements in different proportions. The ordered movement of homeomerics is controlled by "noos" (the world mind).

Plato called primary entities "idea" or "eidos". He endowed ideas with an independent existence and placed them in a transcendental world, where they exist forever. According to Aristotle, the universe is in constant motion. To explain the driving force of motion, Aristotle introduced the concept of entelechy (the first engine). By developing the categorical apparatus of ontology, he described the structure of being. Aristotle considered the categories of essence and phenomenon, genus and species, quality and quantity.

In the 4th century, the Roman Emperor Constantine proclaimed Christianity the state ideology. The main book of Christians was the Bible. It consists of the Old and New Testaments. The Old Testament describes the ontology of the universe. Christianity adheres to monotheism (theocentrism). God is the creator of the universe. Providentialism postulates faith in divine predestination.

The Arab tribes of the Arabian Peninsula, represented by the Prophet Muhammad, became the creators of the new world religion of Islam. Abu Ali ibn Sina (Avicenna) wrote the "Book of Knowledge", in which he gave his own interpretation of Aristotle's books on logic and metaphysics.

Nicolaus Copernicus was at the origins of the general ontology of the physical world. In his book "On the Revolutions of the Celestial Spheres" he used mathematical methods to calculate the heliocentric model of the Solar System. Galileo Galilei formulated a methodology for empirical research of the Solar System and designed a telescope for these purposes. G. Bruno expanded the boundaries of outer space to the Universe.

Ontology of the cognitive process

The formation of science as a type of activity required the creation of a general ontology of the cognitive process, starting with the collection of data to their conceptual processing and systemic use.

Philosophers have proposed ontologies of scientific research in the modifications of empiricism, rationalism and sensualism. Empiricism (F. Bacon) believes that science should be a laboratory experimental science. Its main methods should be induction and experiment. Induction is used to process data. Experiment is used to obtain data in specially created conditions of a scientific laboratory.

Empiricism subsequently became the basis for various varieties of positivism and analytical philosophy. Rationalism (R. Descartes) believes that science should be based on a well-developed theoretical apparatus of mathematics and on the deductive method of constructing scientific knowledge.

R. Descartes outlined this methodology in his books "Discourse on the Method" and "Principles of Philosophy". The analytical geometry developed by R. Descartes in the modification of engineering graphics was used at the Higher Polytechnic School of Paris to train engineers.

Descartes' supporter, a native of Belarus, Kazimir Siemyanovich, developed applied theories of ballistics, pyrotechnics, and rocket science based on gunpowder based on mechanics. He outlined these applied theories in his book "The Great Art of Artillery", published in the Netherlands in Latin and soon published in other European languages.

A prominent representative of rationalism is G. Leibniz. He substantiated the methodology of rationalism in his books "A New Experience Concerning the Human Mind" and "Monadology". Leibniz believed that science should be based on the principles of mathematical logic, not on sensory cognition. The principles of logic are not derived from experience. He formulated the law of sufficient reason. According to this law, any scientific statement must have logical proof.

Leibniz became the founder of the practice of modeling in modern science. Models are built as hypotheses that can subsequently be tested empirically. An ex-

ample of such a model was Leibniz's doctrine of monads. Since it was a purely logical construction, Leibniz did not adhere to a material idealistic interpretation. In fact, he formulated the concept of possible worlds. This concept is currently used in virtual reality technologies.

Sensationalism (J. Locke) believes that scientific research should proceed from the thesis that feelings and sensations are the basis of cognition. J. Locke formulated this thesis in his book "An Essay Concerning Human Understanding." The philosopher opposed innate ideas. In his opinion, ideas arise from sensory experience. In the 20th century, sensualism received a design implementation in the form of sensory technologies.

Failures in the study of natural phenomena and natural objects that took place in astronomy prompted I. Kant to formulate, within the framework of general ontology, the relevance of developing an ontology of the cognitive processes of human thinking. He explained this need by the fact that nature is a thing-in-itself, inaccessible to knowledge. When he formulated this thesis, he realized that the subject of knowledge for philosophy is man and the cognitive processes that occur in his brain.

In his book "Critique of Pure Reason," I. Kant described the features of the cognitive processes that occur in the human brain under the influence of external influence from the environment. When such an external influence occurs, then human rational thinking begins to organize the phenomenon of external influence through a priori categories of space and time. This phenomenon is filled with specific content by a priori categories responsible for semantics (content).

As a result, human experience demonstrates efficiency. Without experience, human thinking is not productive because it falls into contradictions (antinomies). As a result, ontology turned out to be limited only by the subjective semantics of human thinking, the systemic nature of which is given by the a priori structures of reason, represented by the categories of space and time, as well as the explanatory apparatus of categorical structures.

Ontology of the objective and subjective reality of being (linear modification)

Georg Wilhelm Friedrich Hegel attempted to restore a single space of the general ontology of objective and subjective reality. He wrote such books as "Phenomenology of Spirit" and "Science of Logic". Hegel proceeded from the identity of being and thinking in the form of an absolute idea. He needed to use logical means to construct the transition of the absolute idea from a pure state to a state filled with the content of categories. He began with pure being as a being that has no certainty. Through becoming, pure being was filled with concrete content and certainty, expressed in the fact that it has quality, quantity and measure. This is a dynamic equilibrium of the dynamic diversity of opposites.

To show how being is revealed in present being is the essence of ontological thinking. This is what objective logic does. To think the unity of contradictions means to think being. Hegel described the structure of dialectical linear thinking of people. In this structure, he identified three laws of dialectics. The law of the unity and struggle of opposites reveals the source of development through the categories of identity, difference and opposition.

The interaction of opposites is manifested in the form of contradiction. The law of mutual transition of quantitative and qualitative changes reveals the mechanism of development through the categories of quality, quantity and measure.

The law of negation of negation reveals the continuity of the development of human thinking. This continuity is based on determinism, on the mutual connection of cause and effect. Hegel also described in detail the categories of dialectical thinking of people not associated with laws. Among these categories, he described the categories of the singular, the particular and the general, essence and phenomenon, form and content, necessity and chance, possibility and reality. Ludwig Feuerbach returned nature to the space of general ontology.

In the ontology and philosophy of nature, K. Marx and F. Engels proceeded from the thesis that the basis of physical reality is formed by matter in modifications of inanimate and animate nature. Evolution is characteristic of nature. In this

statement, the philosophers relied on the evolutionary theory of C. Darwin, discoveries in the field of genetics and archeological data.

Social ontology was built by K. Marx and F. Engels in the format of a dynamic linear ontology. This ontology proceeds from the inevitability of the transformation and modernization of social structures. In contrast to this interpretation, supporters of structuralism developed a social ontology based on the search in the social space for structures that ensure the dynamic equilibrium of society.

Ontology in the situation of the difference between being and the essence of being

Along with the teachings of E. Husserl, M. Scheler, M. Heidegger, N. Hartmann's version of the philosophy of being is based on the fact that there is a natural system of the world, which is not constructed. Its structure can be found in phenomena. But it is not reducible to either a point or centralized unity, or to a primary cause or the highest goal.

Being is not a certain kind of being. But being is always the being of being. It necessarily consists in a connection, a relationship with being and is always comprehended from it and in it. Since being is not being, the difference between being and being is the most difficult subject of research. M. Heidegger abstracted being from being, putting it forward as a separate and priority subject of philosophical consideration. This move is logically justified, since the meaning of being is revealed in time and for everything finite to be means to be in the same sense. As a result, ontology is a science not about being, but about the essence.

M. Heidegger emphasizes the fundamental difference between being and the essence. The construction of ontology is necessarily connected with the task of clarifying and revealing the essence as the essence. M. Heidegger asks the question of the unity of being, but for him, as for Aristotle, the identity of the meaning of being turns out to be a problem, not a result.

He strives to clarify the basis of the semantic unity of being, and the main difficulty of his ontology consists in the impossibility of moving from the fact of understanding being to the expanded idea of being in general.

M. Heidegger abandoned the project of constructing a fundamental ontology, but continued to search for approaches to being, intending to discover it not by means of science, i.e., to define it not in concepts, but in other concepts that existence dictates. In *Being and Time*, in contrast to traditional metaphysical thinking, a completely different question is posed. Until now, being has been questioned regarding its being. The question in *Being and Time* is no longer about the being as such, but about being as such, about the meaning of being in general, about the openness of being.

Aristotle, guided by the fact that the diversity of what is said must generally relate to something unified, reduced all statements about the being to meanings in which it is explicated in different ways. He interpreted the being as that which exists in an incidental way, according to truth, in the sense of the possible and the actual, and finally, in accordance with the categories. However, in the general sense, its interpretation becomes possible only in relation to what is the essence, to the problem of which the question of what is the being as the being or the being in its being is ultimately reduced.

The significance of the general concept of the being, from which the ascent to the general concept of being must take place, certainly has undoubted importance for M. Heidegger as well. Since he introduces the principle of difference into being itself and interprets it in a slightly different way than Aristotle does, the idea of being in its ontological characteristics, as well as the view of being itself, has a completely different meaning for him.

M. Heidegger assumes being as such, distinct from any being. However, this simple assumption, upon closer examination, must necessarily unfold into the question of the possibility of being of being. For Aristotle, the interpretation of being is possible only in the substantial sense. For M. Heidegger, the existential meaning of being acquires fundamental significance. Existence has a clear priority

in relation to essence, since the assimilation of essence is possible only from existence and on its basis.

For M. Heidegger, being is not an Aristotelian essence in the primary sense. M. Heidegger connects the understanding of the world and the possibility of relating to it with presence, which is being. It is, on the one hand, the basis for the essence, its carrier and that which possesses the essence, and on the other hand, that which is derived from the essential order and introduced into the existential order. Its essence lies in its existence. It is that which simultaneously possesses the essence, or that which is a thing, and that which carries out existence and action.

Applied modifications of general ontology: dynamic ontology of the social being of mankind (linear version)

The general ontology is represented not only by the section on the ontology of physical nature, but also by the section on the ontology of the social being of humanity. This social being of humanity began on planet Earth as a result of the transition of higher primates to the practice of making and using mechanical tools. These tools were needed for hunting animals and for processing their carcasses for use as food and for sewing clothes and shoes.

The biological body of a person was too vulnerable compared to the biological body of animals. Physical weakness motivated people to social organization, which significantly increased the survival of the new population in a hostile environment. Animals and plants usually solve problems of adaptation to the environment through biological protective transformations. They also use social organization for security purposes and to ensure successful hunting.

People, in the ratio of the biological and the social, gave preference to social forms of organization, while preserving the biological genetic basis of population survival, characteristic of living organisms, due to productive birth rate.

Institutionalization of social space led to the natural formation of clan tribal groups with their characteristic features of communication, activity, thinking and behavior. As soon as people formed an ontology of needs, it began to be projected

onto the possibilities of the activities they carried out to satisfy these needs. Despite the dominant intertribal competition, institutions of division of labor were formed both within the clan and tribe, and on an intertribal basis.

In each social group, institutions of power and management were formed. They were represented by modifications of matriarchy and patriarchy. An important role was given to the institution of spiritual power, which had an autonomous status and was coordinated with the management activities of the head of the clan and the chief of the tribe.

At the stage of savagery, humanity cultivated hunting, fishing and gathering. It used the finished products of the Earth's biosphere, subjecting them to thermal and tool processing.

Gradually, some tribes switched to nomadic livestock breeding. Domestic animals were obtained as a result of applying agricultural engineering to wild animals. The choice of domestication technologies fell on wild animals with a high range of tolerance. As a result, cats, dogs, horses, cattle, chickens, rabbits, deer and yaks became man's companions. Without his permission, mice, rats and insects, as well as parasites, became his companions.

Large herds of domesticated animals formed the institutions of the nomadic way of life of mankind. This way of life is determined by seasonal migrations and the search for pastures.

Some tribes followed the path of productive selection of wild plants, which created the basis for a sedentary lifestyle and urbanization. Cities began to shape the topology of agricultural territories. On the basis of agricultural cities, an institution of state power was formed. It performed the functions of management, protection and expansion of the state territory. As a result, military conflicts took place between city-states, as between tribes. They contributed to the formation of the institution of military estates, the army and the navy.

The tribal structures that transformed into the state elite made slave trade a priority rather than mass murder. This valuable human resource was needed for labor on large plantations, in the household and for entertainment purposes.

The institution of slave trade has a rich and long history. It has survived in latent forms until the 21st century. The slave trade played an important role after the great geographical discoveries. It satisfied the demand for cheap labor, which was needed by the plantations of South and North America. The slave trade in their colonies in Africa was carried out by European metropolises.

Traditional agricultural societies were closely connected with the institutions of monotheistic and polytheistic religions and beliefs. Their topology was formed by city-states, eastern despotisms, empires, the great migration of nomadic tribes and the international division of labor with its characteristic logistics of land and sea trade routes.

Traditional agricultural societies were based on agriculture and crafts. High risks of food security were created by agriculture, which depended on climatic factors and the availability of water resources. The traditional societies of Europe were in a particularly difficult situation, since they were located in the zone of risky agriculture. This circumstance became one of the factors in the formation of the institutions of industrial society, in which the main role is given to the efficient production of goods with high added value, a high level of division of labor and high population mobility.

The formation of industrial society institutions resulted in high migration of the population from rural areas to cities, which created a high capacity labor market. Under the influence of the great geographical discoveries, a significant part of the population of Europe began to colonize the New World. Millions of Britons, including the Irish, Spaniards, and Portuguese, moved to the New World. They created farmer and plantation types of agricultural and livestock farming there.

In the international division of labor, they occupied a niche as a raw material base for British industry. The plantation type of agricultural farming was based on the use of slave labor. Industrial societies were formed in continental Europe, including Russia. The regions of North America and Japan followed the path of creating an industrial society. Soon these societies became metropolises.

The rest of the planet became the subject of their colonial interests. But continental Europe became the site of their main military clash. The First World War lasted from 1914 to 1918. It was accompanied by the collapse of European empires. Austria-Hungary, Prussia and the Russian Empire dissolved themselves. New states emerged on the territories they occupied. Austria-Hungary transformed into small states, including Austria and Hungary.

Germany managed to preserve a single territory in the status of the Weimar Republic. Also, the former Russian Empire, with the exception of the territories of Poland and Finland, managed to preserve a single territory under the name of the Union of Soviet Socialist Republics (hereinafter referred to as the USSR). The results of the First World War did not satisfy Germany, Italy and Japan. Germany and Japan were the first to begin preparing the preconditions for the Second World War, with their armed forces landing in China and Korea.

Germany began to implement its dominance in continental Europe by diplomatic and military means. Together with Italy, Germany supported Franco in Spain. In addition to Spain and Italy, Germany's allies included Bulgaria, Hungary, Romania, Slovakia, Croatia and Finland. As a result of the Munich Agreement, Germany gained control of Czechoslovakia through diplomatic means. Turkey was also among Germany's allies.

Germany used military means to subjugate France, Belgium, the Netherlands, Luxembourg, Denmark and Norway. The invasion of Poland by German troops, which began on September 1, 1939, marked the beginning of World War II. In this war, the allied forces of the USSR, the USA and the British Empire confronted each other. They confronted the armed forces of Germany, Italy, Japan and the states allied with Germany. The theater of military operations were different continents and waters of the oceans and seas. Japanese troops acted independently in the Pacific region. Their main opponents were the armed forces of the USA and the British Empire.

The armed forces of Germany acted against the armies of the USSR, the USA and the Briand Empire in cooperation with the troops of other European

states. Thus, divisions from Hungary, Romania, Spain and Italy participated in military operations against the USSR together with German troops. Until the summer of 1944, the allied forces of the USSR, the USA and the British Empire did not carry out joint military operations in a specific region of military operations.

The anti-Jewish policy of the German authorities led to the mass migration of the European Jewish community, which owned huge capital, to the USA. The US financial system took advantage of this unique situation and added to it a well-developed thesis about the reliability of the country's banking system, guaranteeing the inviolability of private and public deposits.

After the Second World War, which ended with the defeat of Germany and Japan, the era of the Cold War began, and at the same time there was a partial collapse of the British Empire and the colonial empire of France. The Cold War against the USSR was initiated by Great Britain and the USA.

This war could not be transformed into direct military clashes, since the participants in the conflict had significant arsenals of nuclear weapons. Therefore, the Cold War was waged in an information format, the purpose of which was the internal disintegration of the state, in particular, the United States pursued such a goal in relation to the USSR.

As part of the information war with the USSR and its European allies, the United States implemented an economic model of a mass consumer society. This model assumed a rapid restoration of the financial system of Western European countries and a high growth in the consumption of mass-produced goods. To implement this program, the United States allocated 20 billion dollars under the Marshall Plan.

The collapse of the USSR occurred at the end of the 20th century, but not so much due to the efforts of the United States, as for internal economic reasons. As a result, on the basis of 15 Soviet republics that were part of the USSR, states were formed that began to independently determine their geopolitical choice. But by the time of the collapse of the USSR, through the efforts of Western transnational corporations, a powerful industrial complex was created within China in the structure

of the world economy, which made China a region of growing geopolitical opportunities. The countries of the Far East (the Republic of Korea and Japan) and the countries of Southeast Asia (India, Malaysia and Singapore) also followed the path of accelerated industrial development.

All of them, except China, were in military-political cooperation with the United States. But it was the Chinese economy that demonstrated impressive growth rates and influence in the international division of labor. As a result, the United States began to view China as the main geopolitical competitor to their global leadership. The United States could not focus on solving the problem of economic and geopolitical contradictions in relations with China, since they were under the strong influence of the European factor, in which they were held by the countries of the old continent.

The benefit of the European countries was to use the United States to continue the strategy of confrontation with the Russian Federation, perceived by analogy with the USSR. The goal of this confrontation was the disintegration of the Russian Federation. But the strategy of the European states also had an economic benefit associated with the use of the myth of the aggressive nature of Russia to ensure their own military security at the expense of the United States. This strategy allowed European states to save significant amounts of military spending, the share of which in national budgets did not exceed two percent.

The 2014 coup d'état in Ukraine, carried out with the support of the United States, gave Western countries confidence that Russia was losing influence in the post-Soviet space and could itself become an object of liberal transformation.

This idea captivated the United States and became a priority in the foreign policy of this state. As a result, Ukraine became the main place of clash of interests of the United States and Russia. The reason was the expansion of NATO to the borders of Russia. Thus, the ontological essence of the social being of mankind is interstate economic and political contradictions.

A special topic in the ontology of social being is the relationship between social being and social consciousness. K. Marx is credited with a variation of the

relationship between social being and social consciousness in the form of economic determinism. According to this variation, the economy shapes the content of political actions to the point that it can determine a radical change in the political elites of the state and political regimes.

It also allows for a complete rejection of the institution of the state in favor of civil society. F. Hayek adhered to the strict positions of economic determinism, excluding state intervention in the natural cyclical dynamics of the market economy even during periods of economic crises.

M. Weber believed that public consciousness shapes the content and efficiency of economic processes. In this conclusion, he relied on the results of a sociological study of the role of the Protestant work ethic in the formation of a successful North American model of a market economy. The facts indicated that the theological and ethical code of Protestant communities contributed to the effective functioning of market economy institutions.

A separate topic within the framework of the ontology of the social being of mankind was the question of the legitimacy of the participation of the subjective human factor in the dynamics of objective reality. This participation was explained by the lack of reliable mechanisms for the dynamic equilibrium of social systems in social being. The reason was provided by the revolutionary events in Europe, which led to a radical transformation of state institutions and created a threat to market economy institutions. One of the weak points in the market economy was the period of economic crisis.

During the Great Depression in the United States, they decided to use the economic philosophy of J. Keynes. This philosophy allows for the intervention of the state institution in the natural functioning of the market economy in order to mitigate the social and political consequences of the crisis for a particular state.

The main method of state intervention is the use of the mechanism of internal and external debt to support the banking system and industrial companies, on which the purchasing power of households and employment of the working population directly depend. But these mechanisms also have a negative side associated

with the growth of internal and external debt, as well as credit debt of the population and companies.

Representatives of structuralism drew attention to the more economical effect of ensuring the dynamic equilibrium of national society. They believed that the ontology of social being has a stable architecture of dynamic equilibrium at the level of civil society structures. They began to look for these stable structures in various societies on the planet in order to prove their universality and presence in all communities, regardless of their cultural differences.

In US sociology, the emphasis was placed on the structural and functional analysis of the social structure of US civil society in order to identify a value system capable of suppressing contradictions and preventing them from entering the sphere of state institutions. The model of checks and balances in the functioning of the constitutional, legislative, executive and presidential authorities also began to be applied to state institutions. A mechanism for transferring some of the powers to the states within their territorial competence was also implemented.

One of the areas of social ontology was the topic of anthropogenic pressure of industrial society on the Earth's biosphere and the ability of humanity to combine the adaptive capabilities of the Earth's biosphere with the growing anthropogenic pressure on it. Representatives of environmentalism at the University of Chicago proposed an option for modernizing the infrastructure and communications of an industrial city to meet ecosystem standards. This option was tested in the urban environment of Chicago and the Great Lakes. It was successful, but it was local.

In order for such a philosophy to be implemented globally, strategies for the development of humanity were formulated without harming future generations. They were concretized by the signing of environmental protocols in Kyoto, Montreal, Paris and Johannesburg. The states of the European Union and the United States began to implement green economy technologies in energy, industry and agriculture. But with the expansion of the territory of industrial society to other continents, the volume of emissions began to grow. Developing industrial states do not have investments to implement the tasks of the green economy.

Thus, social ontology includes in its structure the human factor, which formulates planetary tasks for itself, but cannot solve them on a planetary scale due to the uneven distribution of material resources and numerous contradictions that generate conflicts and the priority of local interests. From the point of view of military security, humanity can only hope for the role of parity in nuclear weapons among leading states. From the point of view of environmental security, humanity can only hope for the adaptive capabilities of the Earth's biosphere in the context of growing anthropogenic pressure on it.

The hope for globalization did not come true, since it turned out once again that it is only one of the tools of humanity not for creating a single space of life, but for solving local interests of colonizing the continents of the Earth and localizing in the coordinates of the developed area.

This was the case in the historical eras of the great migrations of peoples, and this is what happened in the historical era of the formation of industrial society. The same thing happened during the era of transformation of Western industrial companies and banks into transnational structures with specific national interests. In the sphere of global politics, liberalism is increasingly giving way to Trumpism with the priority of national state interests.

Applied modifications of general ontology: dynamic ontology of the social being of mankind (non-linear version)

The theme of the dynamic ontology of social being of humanity in the non-linear version was actualized in the second half of the 19th century in Europe, when archaeologists during expeditions in Asia, Africa, Europe and America discovered the infrastructure and urban communications of previously existing civilizations in the form of separate cities and states. These perished civilizations existed at enormous distances from each other. The reasons for their demise were military invasions, environmental disasters, internal contradictions and depletion of internal resources for sustainable development.

The non-linear version of the dynamic social being of humanity is based on the principles of non-rigid determination. Emergence, probability and chance play an important role in this determination. Examples of such non-rigid determination are given by the general ontology of being. Examples include the Big Bang, deterministic chaos and self-organization.

In classical philosophy, non-linear dynamics was considered the starting point of the general ontology of being. This starting point was symbolized by Chaos. But then, through self-organization, Chaos was transformed into a social order with its characteristic cause-and-effect dynamics. After all processes of social being began to be associated with their predictability, the non-linear version of social dynamics found itself in the range of strong limitations.

Non-linear dynamics began to be understood not as some independent process, but as manifestations of non-linearity in linear processes. The mathematical apparatus for describing these non-linearities was created in the form of probability theory. This theory allows us to detect variable patterns in dynamic processes.

The theory of economic cycles developed by G. Kondratiev describes the dynamic ontology of a market economy as a series of cycles. Although these cycles are known, the specific time of their occurrence is not always known with high accuracy. Market economy participants are especially interested in signs indicating that the global and national economies are entering a crisis stage. One of the reasons for the uncertainty of the situation is considered to be the lack of objective information and objective statistical data.

The lack of data and information has created the need for banks and industrial companies to insure risks. As a result, a niche of the insurance business has emerged in the market economy. Risk insurance is relevant for national and international banks. It is also relevant for the family budget.

Risks arise not only from the lack of data and information about human activities. They are also formed by the nonlinear dynamics of natural processes. The content of this nonlinear dynamics is formed by hurricanes, typhoons, tornadoes, tsunamis, earthquakes, droughts, floods and sudden cold snaps.

The limited range of nonlinear processes is largely formed by the fact that in the Universe the laws and fundamental constants are the same at all times and in all directions. Galaxies accumulate in the same way in all observable directions. Similar gravitational phenomena occur with them.

They exhibit similar internal dynamics, regardless of the place or time in the Universe where the observer is looking. If this were not the case, then the question of whether the laws of gravity and the fundamental gravitational constant, G , change with time or place would become relevant.

In a similar scenario, electromagnetic and quantum phenomena would change with place or time, or differ with direction. But these changes are not observed at the level of electromagnetic and quantum laws and constants.

Many theoretical reasons have been found for why Planck's constant, the speed of light, and Newton's gravitational constant have constant values. This does not exclude the possibility of small fluctuations in the values of these parameters in time and space.

Nonlinear dynamics uses nonlinear models described by differential equations and discrete mappings to describe systems. Its conceptual apparatus includes stability theory, dynamical chaos theory, ergodic theory, and the theory of integrable systems. A dynamic system is a system of any nature whose state changes discretely in time. In such systems, under certain conditions, parametric oscillations may occur. Parametric resonances are dangerous in machines and structures, since growing parametric vibration is possible even in the presence of damping.

The basic foundation of nonlinear dynamics is formed by:

- 1) the theory of dynamic systems,
- 2) the theory of stability and bifurcations,
- 3) the mechanisms of formation of deterministic chaos modes,
- 4) fractal theory and dimensionality. One of the central concepts of nonlinear dynamics is the concept of "system". Any system is characterized by a certain set of quantities.

Nonlinearity of an effect or phenomenon means a state, and nonlinearity of a theory describes this state by conceptual means of nonlinear dependence. Mathematically, dependencies are expressed by nonlinear functions of one or more variables. A mathematical model of a dynamic system is considered given if quantities are introduced that uniquely determine its state, and the law of evolution of the state in time is specified. Among dynamic systems, dynamic systems with continuous time (flow models) and dynamic systems with discrete time (mappings) are distinguished.

Chaos theory contains a mathematical apparatus describing the behavior of some nonlinear dynamic systems that are subject, under certain conditions, to the phenomenon of dynamic deterministic chaos. The behavior of such a system seems random, even if the model describing the system is a deterministic model. Chaos theory assumes that complex deterministic systems depend on initial conditions: small changes in the environment can lead to different consequences, which makes predictions of their behavior difficult.

Mathematical systems with chaotic behavior obey laws and have a certain order, for example, quantum chaos theory studies quantum systems that demonstrate chaotic behavior similar to classical analogs. The conceptual idea of chaos theory was realized by Henri Poincaré. He proved the recurrence theorem. A. N. Kolmogorov and V. I. Arnold, as well as Yu. K. Moser, developed the theory of stability. It studies invariant tori in integrable systems under small perturbations.

The conceptual apparatus of chaos theory contains the concept of an attractor, including strange attractors with a self-similar structure, with complex dynamics characteristic of them.

Among continuous systems, only non-planar spatial systems have chaotic behavior. They must have at least three dimensions or non-Euclidean geometry. A discrete dynamic system at some stage may exhibit chaotic behavior even in one- or two-dimensional space.

Sensitivity to initial conditions is known as the "butterfly effect". The term arose in connection with the article by E. Lorenz "Prediction: A butterfly flapping

its wings in Brazil will cause a tornado in Texas." A butterfly flapping its wings symbolizes small changes in the initial state of the system, which cause a chain of events leading to large-scale changes. Topological mixing in chaos dynamics means such a scheme of system expansion that one of its regions at some stage of expansion overlaps any other region.

Applied modifications of general ontology: anthropological ontology

Human ontology is built in the theological version on the principle of God's creation of all existing reality. Under the influence of Darwin's evolutionary theory, human ontology is based on the principles of heredity, natural selection and the struggle for existence. Under the influence of archeological data, human ontology is based on the principle of the human body expanding with artifacts. The first artifacts confirming the expansion of the human body were mechanical tools.

As a result, the organic human body became combined with inorganic components of physical nature. The extensions of his arms and legs created by man are autonomous artifacts. Their life cycle differs from the biological life cycle of the human body. Representatives of Marxism recorded biological, mental and social components in the ontology of man as a generic being.

The biological component indicates the important role of population characteristics of humanity and the biological reproduction of the population associated with the functioning of a living organism and its need for energy, satisfied by the consumption of biological resources of the ecosystem. The vulnerability of the biological nature of an individual has accelerated the development of mental components of the nervous system, primarily the brain as a central information structure with which the periphery of receptors is integrated.

As a result of the intensive work of the brain with information, a complex of reactions of an unconditional and conditional nature has formed in its structure. Unconditional reflexes are inherited from generation to generation. Conditioned reflexes contain a resource for the adaptation of the nervous system of a person of

a specific generation to specific historical and local conditions of the external environment and collective life.

The information acquired by the human brain is systematized and ordered by the structures of consciousness, in which thinking plays an important role. The main content of the ontology of man as a generic creature at the stages of savagery and barbarism was formed by the task of adaptation to the external environment.

For this reason, the shortcomings of the biological body of people were compensated by the institutions of their social organization, in which communication and the linguistic means of its implementation began to play an important role.

Another aspect of the subject matter of anthropological ontology was formulated by philosophy at the level of man as an individual. The specifics of this aspect are formed by fundamental questions within the boundaries of individual life and death. Human ontology from this perspective formulates the question of the primary givenness of the existence of an individual (existentialism). The thesis about the individual's abandonment in the current social being is also formulated. This abandonment means the prospect of freedom and borderline situations that test the individual according to the criteria of being.

Not all individuals pass the test of humanism and the ability to follow the values of freedom. This is manifested in borderline situations created by wars, epidemics, love affairs and the thirst for money. World fiction, created on the basis of the philosophy of existentialism, is represented by the works of F.M. Dostoevsky and L.N. Tolstoy, A. Camus and J.P. Sartre, became an illustration of the significance of the conceptual apparatus developed by the philosophy of existentialism. In Belarusian fiction, the theme of border situations was created by the events of the German occupation that took place in 1941-1944.

These events included a virtually permanent regime of border situation between life and death, created by the occupation authorities of Nazi Germany for the civilian population. The Nazis threatened to shoot every citizen for racial, ethnic and other reasons. Settlements and communities found themselves in a border situation. Representatives of psychoanalytic philosophy tried to discover the ontology

of the individual in his mental structures. Z. Freud developed a model of these mental structures in the form of levels of unconscious reflexes, subconscious reflexes and conscious reflexes.

He assumed that there are complex relationships between these levels of reflexes. Only conscious reflexes, which are within the competence of the individual's thinking, are capable of responding to this complexity. Unconscious reflexes are based on the instinct programs inherited by the individual. They do not imply reflection. They are realized by the mechanisms of automatism and have a two-level structure of individual and collective unconscious action. K.G. Jung was one of the first to discover that collective unconscious reflex structures of instinct are destroyed by the rationalism of industrial society.

This destruction is manifested in the depopulation of industrial societies. Biological reproduction of the population and the genetic continuity of generations are violated by the arguments of family planning, gender equality, the priority of career and social status.

The reason is not the dire financial situation, which is more typical for developing countries, but the introduction of the sphere of unconscious biological life of a person into the space of rational reflection. As a result, objective grounds for labor migration were formed. As a consequence, contradictions associated with labor migration have become more acute in industrial societies.

Subconscious reflexes of mental structures are inherited through cultural codes. Their ontological basis is formed by irrational mental structures that generate a special semantics of dreams and intuitions.

In the context of general ontology, man can be considered as the realization of a certain stage of self-organization of actual being. A sign of this self-organization is the evolution of the information space of the physical universe. In this space, interactions in the form of energy processes are realized between the object structures and the material environment.

The feedback between these processes at the level of inanimate nature is manifested in the formation of the metrics and topology of the material environ-

ment, and also manifests itself in the interaction of object structures. Through the human brain, the physical universe has acquired a tool for self-observation and self-reflection.

Man has become so carried away by this mission, set by general ontology, that he is not limited to the function of observing actual being. It promotes the expansion of the dynamic diversity of actual being through the actualization of the resources of potential physical being, including the transfer of the functions of one's own brain to cognitive artifacts external to one's biological body.

As a result, man has created for himself the status of an intermediate evolutionary link within the framework of universal evolutionism. With his creative efforts, he is preparing a replacement for himself. Man has begun to give way to the posthuman and the cyborg.

If man as a generic being were only within the limits of his own ontology, he would not have created for himself the status of an intermediate link. This means that in man there is not only an intention oriented toward the priority of his own ontology, but also an intention formed by the general ontology of the existence of the physical universe. These two intentions can be considered as a contradiction of human nature. It remains only to find out whether this contradiction will be positive for man himself as a generic being.

Applied modifications of the general ontology: ontology of technology

Technology is a modification of potential being. But this being, unlike nature, is incapable of being actualized independently. Therefore, for actualization, this potential being needs a mediator. Man as a generic being became such a mediator. Historically, man actualized technology in the form of mechanical tools. Machines became the second modification of technology.

Mechanical tools are used by people in various activities. Gradually, these tools began to be replaced by machines. These technical devices have their own autonomous drive and significantly increase the efficiency of activities up to the

imitation of human thinking and decision-making functions. In addition to various areas of activity, machine technology has proven to be in demand in communication processes.

Philosophers have long adhered to the thesis of the neutrality of technology formulated by Aristotle. But during the first industrial revolution, this thesis began to lose force, since the Luddite movement showed that technology is not neutral in relation to social ontology. In the 19th century, E. Kapp substantiated the thesis that technology is not neutral in relation to anthropological ontology either, since technical devices are a natural extension of human organs.

Understanding the connection between the ontology of technology and social ontology and anthropological ontology has become central to philosophy. In the interaction of the ontology of technology and social ontology, technology began to play a negative role. The last stage of development of world culture was associated with technology (N. Berdyaev and O. Spengler). M. Heidegger discovered the negative influence of technology on people's thinking. Instrumental thinking took the place of meaningful reflection.

G. Marcuse believed that technology made the individual a one-dimensional person. Accusations against technology showed that the creator of technology turned out to be vulnerable, but he cannot forbid himself from updating the next generations of technical systems. It is impossible to say for sure how this mission for man as a generic being will end.

Applied modifications of the general ontology: dynamic ontology of the biosphere ecosystem

One of the applied modifications of the general ontology is the dynamic ontology of the biosphere ecosystem. So far, the empirical material for studying this ontology is provided by the ecosystem of the biosphere, which was formed on one of the planets of the Solar System. This planet is the Earth. The applied importance of studying the dynamic ontology of the biosphere ecosystem is due to the discovery of exoplanets with the probability of the existence of biosphere ecosystems on

them. To form an ecosystem of the biosphere, certain dimensions of the planet, a solid surface on the planet, the presence of water, a certain range of temperatures, a magnetic field, the presence of an atmosphere and an optimal distance to the star that formed an ensemble of its own planets and cosmic bodies are needed.

It is obvious that as the technological capabilities of humanity grow, it will develop planets that do not have all the conditions for the formation of a biosphere ecosystem. Humanity plans to colonize the Moon and Mars.

But the presence of a favorable biological environment is a less expensive option for colonizing planets. In this context, colonization is not understood as the forceful seizure of the planet's living space, but as integration and adaptation to the biological ecosystem of the planet, which is at the initial stage of formation in the absence of creatures in its space that are similar to humanity in terms of cognitive development.

If humanity is faced with the fact of the presence on an open planet of creatures similar in cognitive development to it and even surpassing it in cognitive development, then there is no reason to talk about colonization. The priority will be either a dialogue between space civilizations or a confrontation between them, which does not exclude colonization.

But since a significant part of humanity plans to remain in the space of the ecosystem of the Earth's biosphere, one of the key themes of dynamic ontology is the transformation of a purely biological ecosystem into its hybrid modification, due to the growing role of the anthropogenic factor in this transformation.

This factor also has a biological basis, since man as a generic being is a product of the biosphere. But the biological basis of man as a generic being is actively supplemented by many artifacts of the cultural environment. And then questions arise about the prospects for the joint evolution of different ecosystems within the Earth's biosphere. This new subject field of general ontology is designated as ecological philosophy.

Analytical version of the ontology of consciousness

Analytical philosophy is characterized by criticism of pseudo-problems, scientism (connection with science) and empiricism (trust only in facts), pragmatism (emphasis on the practical benefits of knowledge). The ideals of clarity, precision and logical rigor of thinking are cultivated.

The basis of the analytical tradition was formulated by the works of Gottlob Frege, the logical-semantic analysis and philosophy of common sense of George Moore, the logical atomism of Bertrand Russell, the logical positivism of the Vienna Circle, the Lvov-Warsaw School, the philosophy of ordinary language of the Oxford School, as well as the concepts of the early and late L. Wittgenstein.

The main representatives of the second wave of analytical philosophy were John Searle, Daniel Dennett and David Chalmers. Based on intentionality, J. Searle in his book "The Rediscovery of Consciousness" (1992) showed that philosophy found itself in a position of false dichotomy on the one hand, the world consists only of objective particles, on the other hand, consciousness has subjective experience from the first person. Both positions are correct: consciousness is a real subjective experience associated with physical processes in the brain. This position began to be called biological naturalism.

D. Dennett for a philosophy of consciousness that would have a basis in empirical research. In his dissertation "Content and Consciousness" he divided the problem of explaining the mind into the need for a theory of content and a theory of consciousness. He published a collection of essays on the topic of the content of consciousness.

D. Chalmers put forward a thesis on the hard problem of consciousness. He has established a distinction between easy problems of consciousness and the hard problem of consciousness, which can be expressed by the question: "Why does the perception of sensory information exist at all?" The subject of the study was the difference between the biological work of the brain and behavior, and mental experience, which is considered separately from behavior as qualia. In his opinion,

there is no comprehensive explanation for the differences between these two systems. He did not criticize the materialistic explanation of mental experience.

As evidence, he put forward the hypothesis of a philosophical zombie, who is a normal person but lacks qualia and sentience. He argues that since the existence of zombies is possible, the concepts of qualia and sentience have not yet been fully explained in terms of physical properties.

D. Chalmers admitted that consciousness originates in any information system and took the position of preanimism. According to this position, any physical object has consciousness.

Quine's student at Harvard University was Saul Kripke, who became one of the most famous modern analytic philosophers. He was interested in the fields of modal logic and semantics, philosophy of language, and set theory. Another student of Quine was David Lewis. He is considered one of the greatest philosophers of the 20th century, since he developed the theory of modal realism. Thomas Kuhn is known for his works in the field of the history of science and the philosophy of science. After strengthening in the analytic tradition of philosophy of mind, the works of Hilary Putnam, Donald Davidson, Daniel Dennett, Douglas Hofstadter, John Rogers Searle, Patricia and Paul Churchland gained fame.

In its modern form, analytic philosophy of mind is closely related to cognitive sciences, in particular, to logic and the theory of artificial intelligence.

Ontology in information systems

In the context of information technologies for knowledge representation, the term ontology denotes a mechanism, a method that is used to describe a certain area of knowledge of a subject area or domain, the basic concepts of this area, their properties and the relationships between them. In this context, ontology is defined as a specification of conceptualization.

Conceptualization means an abstract representation of a subject area. Ontology includes a reliable semantic basis for defining content; a general logical theory, which consists of a dictionary and a set of statements in a certain logical lan-

guage; a basis for communication between people and computer agents. They allow new concepts to be represented in a way that makes them suitable for machine processing. Ontologies enable synergy between new concepts that the system has not yet encountered and descriptions of already known classes, relations, properties and objects of reality.

The components that make up ontologies depend on the representation paradigm. All ontology models contain concepts (concepts, classes, entities and categories); properties of concepts (slots, attributes and roles); relations between concepts (links, dependencies and functions) and additional constraints. They are defined by axioms, in some paradigms by facets.

Taxonomies are sometimes considered as complete ontologies, although ontologies should not be limited in this way. Taxonomies are widely used to organize the ontological knowledge of a domain using relations of generalization and specialization, through which simple and multiple inheritance can be applied. Relationships represent the type of interaction between domain concepts.

Axioms are used to model statements that are always true. They can be included in an ontology for several purposes, such as restricting the information contained in an ontology, checking its correctness, or inferring new information. The term instance is used to represent elements in the domain, i.e., an element of a given concept. An ontology together with a set of individual instances constitutes a knowledge base. Ontologies consist of hierarchical descriptions of important concepts in a domain, together with descriptions and editing tools.

Ontology engineering can be defined as a set of activities that concern the process of ontology development; the life cycle of ontology; methods and methodologies for constructing ontologies; and a set of tools and languages for their construction and support.

Philosophers have shaped the concepts that were later developed by computer scientists and eventually led to the creation of artificially intelligent systems. Willard Van Orman Quine could be such a philosopher. He continued the approach of Bertrand Russell with its emphasis on formal logic and ontology. This is evident

in Quine's 1948 article "On What Is." Quine's work was referenced by Massachusetts computer consultant George H. Mealy in "Another Look at Data" when he used the term "ontology" to describe his model.

His theoretical model of data and data processing models are a system of sets of entities, values, data maps, and procedure maps. Entities correspond to real-world objects about which data is recorded or calculated. Data maps assign values to attributes of entities. Structured data, as a special type of data map, are a set of entities themselves; structured maps consist of pointers. Procedures denote operations on data maps that create new data maps. Data processing occurs in the memory of the computing system, which is ideally a representation of the real or abstract system being modeled.

Data description is defined as a specification of systems and representations of machine data. A data type is a fragment of a data description that describes an object and its applicable maps. Standardization of data description methods is more important than standardization of data representation methods and procedure specifications. A historical analysis of the development of ontology from philosophical beginnings to ontology in computer and information sciences is presented in Giancarlo Ghizzardì's doctoral dissertation "Ontological Foundations of Structural Conceptual Models", which examines ontologies in information systems and the semantic network.

Ontologies use a predefined reserved vocabulary of terms to define concepts of relationships between them for a specific subject area. With the help of ontologies, it is possible to automate the processing of data semantics for the purpose of its effective use (representation, transformation and search).

The corresponding principle of data processing is based on the presentation of the description of the subject area as a knowledge base containing concepts and relationships, and is focused not on human comprehension of information, but on automated interpretation and processing of information. The use of ontologies in information systems allows us to reflect the real picture of the world in the form of concepts, relationships and perform various interpretations.

Ontology of intelligent systems

The development of an information system begins with the process of analyzing the subject area and building an ensemble of models that describe the subject area, the tasks set and the restrictions (requirements) put forward by the customer from different sides. The constructed models are subject to revision by the customer, usually slightly adjusted and transferred to implementation. A team of programmers creates a program code for the information system based on the models and descriptions collected by analysts at the first stage, its verification is performed and the stage of system implementation begins.

In the subject area, based on the classification of basic terms, the main concepts are identified and connections between them are established - their conceptualization occurs. The ontology can then be represented graphically or described in one of the formal languages (formal ontology). This involves the process of ontology specification. The ontological representation of knowledge is used for the semantic integration of information resources, adequate interpretation of the content of text documents presented in natural language.

Ontologies are descriptions of knowledge that are formal enough to be processed by computers. Such formal descriptions are used in various areas of computer science. Ontologies are used as interfaces of intelligent systems.

The term "ontology" first appeared in the work of Thomas Gruber, who considered various aspects of the interaction of intelligent systems with each other and with humans. Intelligent systems are programs that model some aspects of human intellectual activity. Any computer program is engaged in such modeling to one degree or another.

The knowledge that the creator of the program puts into it (the algorithm of this program) is always static, it does not change, with the exception of specific knowledge (program data). An intelligent system is a more universal system. In it, the knowledge of what to do during the execution of the program is not included in the program once and for all, but can change. If so, then this knowledge must be transferred to the program as data, therefore, there is a need to describe it.

The knowledge that is embedded in computer programs can be divided into two types. Procedural knowledge contains knowledge about what needs to be done in each specific situation.

In addition to procedural knowledge, each program needs declarative knowledge about what payments, transactions, accounts and things are. Without this knowledge, the program will obviously not be able to function, it will be impossible to build an algorithm for a software system. When creating an intelligent system, it is necessary to take into account such a division of knowledge and develop software tools for operating this knowledge. If knowledge can be encoded in any way within an intelligent system, then in order to exchange this knowledge with another intelligent system, it is necessary to provide a description of this knowledge. This description must be formal enough to be understandable to another system, and the language of this description must also be known. In addition, the description must also be understandable to a person.

In canonical form, a description is a description of knowledge in the language of predicate logic. In the form of an ontology, a description is a set of classes related to each other by a generalization relationship. This is the inverse relationship for the inheritance relationship.

Ontology is a description of declarative knowledge, made in the form of classes with a hierarchy relationship between them. Attached to this human-readable description is a canonical description intended for AI. Each intelligent system can provide several such descriptions corresponding to different areas of the declarative knowledge stored in it, and thus acts as a repository of an ontology library. Intelligent systems are treated as ontology libraries. They can freely exchange ontologies with each other. In this case, an ontology library no longer has to be an intelligent system; it is enough to simply provide an ontology transfer service on demand.

Creating a description of declarative knowledge requires a lot of work and certain skills. The term "conceptualization" is used to denote this work. The de-

scription is designated as a "specification". As a result, an AI ontology is defined as a specification of conceptualization.

Separating knowledge specifications into a canonical form and an ontology is not very convenient, since the same knowledge has to be described twice. Modern ontology description languages allow these forms of specifications to be combined into a single whole. Currently, ontology is understood as any description of declarative knowledge made in a formal language and supplied with some classification of the specified knowledge, allowing a person to perceive it conveniently.

The canonical form does not necessarily use the language of predicate logic; other formalisms can be used. It is possible to use an algebraic approach to describing knowledge, in which facts are presented as terms, and various relationships between facts are presented as restrictions imposed on the type of these facts and expressed in the form of equivalence axioms. But any such description must include a representation of declarative knowledge in the form of a hierarchy of class objects. Only in this case can this description be considered ontology.

In a narrow sense, the term "ontology" is used only for specifications of knowledge, the purpose of which is to describe the structure of being regardless of any engineering task. Philosophers have long been engaged in such conceptualization, and in philosophy the term "ontology" is used as a specification of knowledge about the surrounding world. Programmers carry out conceptualization in order to build a model of the problem being solved. For what purposes might it be necessary to construct ontologies in the philosophical sense? Specifications of this kind are necessary for the task of merging ontologies.

To merge ontologies, these ontologies must be somehow coordinated with each other. Terminology must be coordinated, terms denoting the same classes must be identified. The facts described must not contradict each other. Only in this case can one try to merge two different specifications into one specification.

The merged ontologies are first attached to the philosophical ontology, and on the basis of this attachment, the merged ontologies are coordinated. Philosophi-

cal ontologies in the vast majority of cases describe very abstract knowledge, without any specifics, so they are often called top-level ontologies.

Formal ontologies

Edmund Husserl in his *Logical Investigations* introduced a distinction between formal logic and formal ontology. Formal logic deals with the interrelations of truths (or propositional values in general) - with the relation of derivability, with consistency and general validity. Formal ontology deals with the interrelations of things, with objects and properties, parts and wholes, relations and aggregates. Formal logic operates with relations of derivability, which are formal in the sense that they are applicable to inferences by virtue of their form alone.

Formal ontology operates with objects of all material spheres and areas of reality. Formal ontology is based on the theory of dependency and topology. The theory concerns horizontal relations between coexisting parts, relations that give unity to the wholes under consideration.

Some parts of a whole exist side by side, they can be destroyed or removed from the whole without causing any damage to it. F. Brentano formulated the idea of what he called "descriptive psychology," a discipline that would, on the one hand, provide accurate knowledge of the structures and categories of mental life and, on the other hand, provide epistemologically reliable foundations for other areas of philosophy.

Descriptive psychology is a descriptive ontology of mental structures. This entails the thesis that the appropriate form of description for each case under consideration implies something like a taxonomy of the various kinds of constants in the given area and the various forms of relations between these constants. Something like the attitude of descriptive or taxonomic realism arises.

Inner perception is the source of knowledge of the nature of being, just as it is the source of knowledge of the nature of truth and the nature of good and evil. And anything that can be said about the being of things that are not perceived in inner perception can only be understood by analogy with what people are able to

say about themselves as thinking subjects. The result was a three-member division of descriptive ontology. It includes the ontology of things, the ontology of states of affairs, and the ontology of evaluations.

The ontology of things arises from the study of non-psychological correlates of acts of representation. A thing is considered as a possible correlate of representation, including simple and complex semantic data. In the ontology of things, F. Brentano studied collectives and spatial and temporal continua. The result was the assertion that only things exist.

The ontology of states of affairs arises in the case of the transition from the psychology of judgment to the study of ontological correlates of acts of judgment. According to F. Brentano's existential theory of judgment, the ontological correlates of acts of judgment will have a primary form.

It looks like the existence of A and the non-existence of A. "A exists" means that A is such that everyone who judges it must obviously accept it. "A does not exist" means that A is such that everyone who judges it must obviously reject it

The ontology of evaluations arises in the transition from the psychology of feelings, will and preference to the study of the ontological correlates of the corresponding acts. F. Brentano analyzed the Aristotelian distinction between "being in the sense of categories" and "being in the sense of being true" in such a way that it can be considered as belonging to the sphere of general ontology.

Categorization

Categorization is the process of distributing various data into categories or thematic groups based on semantic similarity. Categorization is a rather labor-intensive activity that requires a lot of resources and time. Therefore, the only way out is to automate it. In this case, categorization can be supervised and autonomous. In the first case, external factors are involved. For example, categorization results can be adjusted for the better by a person. In the second case, the process of distributing information into groups occurs independently of any intervention.

The decision on the type of categorization is made based on the tasks at hand. For example, is it necessary to make this process completely autonomous and only use the categorization result, or is it important to take into account the expert's opinion for greater reliability? In large corporate systems, preference is given to autonomous categorization. This is quite logical, since even a high-class specialist will not be able to withstand a heavy workload.

The maintenance of a dedicated department does not seem justified either from an economic point of view or from the point of view of reliability and security. In these conditions, the efficiency of automatic categorization is of particular importance. Various methods and their modifications are used in categorization: statistical (calculation of weighting coefficients and selection of frequency keywords); probabilistic (based on Bayes' theorem); vector, when the text is presented as a feature vector; linguistic (lexical portraits of documents); latent semantic indexing; algorithms using neural networks, etc.

Categorization can also be performed using templates based on comparison with digital fingerprints of template documents containing confidential information. If the result is positive, for example, when a certain threshold of similarity is reached, the new document is assigned the category to which the template document belongs, or a mark is put that the document is confidential.

Among the requirements for the methods, we can highlight scalability (the number of documents should not significantly affect the algorithm's running time) and versatility (minimum number of settings).

Each of the listed categorization algorithms has a certain value and is used in various systems. For example, statistical, probabilistic methods and digital fingerprints of documents are often used. However, to improve the efficiency of categorization, it is necessary to use new methods, one of which is categorization based on ontologies.

They imply a formal description of a certain subject area using concepts and their relationships. Ontology includes classes of the subject area or areas (in this case, classes and concepts are synonymous and are used to denote general things);

properties of concepts (or attributes, in some sources they are called roles); instances (examples of specific things); relations; restrictions and rules.

The process of creating an ontology involves identifying classes, that is, those concepts that reflect the essence of the subject area; identifying the most general classes, which include other, more specific cases; setting class properties and defining the boundaries of acceptable values; specifying specific instances (examples) for classes (DOS attack).

When developing ontology, it is necessary to understand that any created ontology should not claim to be the only correct version of describing a specific subject area. Several ontologies may exist for the same subject area, and all of them will be correct depending on the tasks set.

With respect to DLP systems, the influencing factors may be: the volume of the company's information flow, the customer's requirements for the depth of description detail, the scale of the company's activities. In a specialized organization, the number of subject areas is not as large as in a company with a wide range of activities (CRM solutions vendor vs. systems integrator).

Ontology model

A mathematical model of ontology has been developed that uses the concept of a metaobject. Ontological modeling based on this model includes specification, conceptualization, and formalization. At the specification stage, a glossary of terms is built. At the conceptualization stage, domain objects and their hierarchy are defined, and relationships between objects are identified. At the formalization stage, metaobjects and relationships between them are defined, which correspond to objects and relationships between objects. This is the domain ontology.

At the actualization stage, the parameters of domain objects and their values, classes, subclasses, and class instances are defined. Parameters, parameter values, classes, subclasses, and class instances are implemented in the ontology as metaobjects of the corresponding types. In order to clarify, specify or generalize the goal

as it moves towards it, to understand space, time, and the cause-and-effect series, AI should not be provided with an a priori model of the environment.

Also, for a large-scale understanding and assessment of the situation, making adequate decisions, taking appropriate actions, possessing the ability to self-identify and strategically plan, it should not be provided with an a priori model of the environment in which it is located. But ontologically it can and should be related to it. The ontology of AI should correspond to it. Such ontology is implicitly contained in the language.

The highest level of any ontology is a system of categories based on universal categories. Such categories and their relationships can be derived by generalizing the meanings of parts of speech and members of a sentence, since it is the sentence that expresses a complete thought. As a result, we obtain a system of interconnected general categories, which can be represented as a directed graph. This form of representation allows us to display not only the ontological status of general categories and derived concepts, but also their relationships

The causochronotope of coexistence contains a set of manifolds that are not yet categories in the strict sense. To become, for example, a space, it is necessary to set a metric in the ontological manifold or derive it from specific measurements, units and their relationships.

An open elementary cell of the graph of a set of ontological manifolds can be supplemented with other coexistences. In an extremely general form, the relationships of categories are already contained in this elementary cell of the graph of ontological manifolds, and are displayed in it.

The fact of creating a full-fledged, self-sufficient AI or successful productive work in this direction can act as a kind of verification of a particular ontology already at intermediate stages. At the same time, something new, specific to artificial consciousness, may appear in each of the specified groups. Perhaps the emergence of self-sufficient AI will be associated with the emergence of a radically new type of ontologies.

A fuzzy approach to ontology will be new, since dynamic fuzziness is a more general, fundamental form of existence and its understanding in relation to all types of clarity, a measure of the feasibility of events, a mode, a way of existence that is not reflected by clear ontologies. In this achieved context of worldview, clarity acts as a particular, extreme or ideal case of fuzziness, as a rule, unattainable in reality in a finite historical period.

Fuzzy disciplinary ontologies that cover a wide variety of possible phenomena and situations work better. This is a methodology that includes a fuzzy understanding and vision of the phenomena that modern science encounters. It motivates the creation of conceptual and categorical apparatuses capable of working with objects of fundamentally fuzzy forms of existence and expression, fuzzy ontology.

The implementation of this methodology is possible by referring to a system of fuzzy general categories and derived concepts, the core of which can be represented as a fuzzy graph of fuzzy categories that fit into the understanding and explanation of objective reality.

There are two ontologically, gnoseologically and axiologically interconnected phenomena: the phenomenon of man and the phenomenon of the universe. Without understanding one, it is impossible to understand, evaluate and master the other phenomenon. Until now, both remain largely misunderstood and, accordingly, unappreciated and unmastered and exist spontaneously.

A rethinking of both phenomena is taking place. This is due to the discovery of dark matter and dark energy of an unknown nature (interpreted as a cosmic vacuum), quantum teleportation, the emergence of unconventional scientific concepts of the universe, such as multiverse and phasiverse. A new idea of man is being formed, who has come close to creating a thinking entity of a different kind.

AI is created historically as an asymptotic process. General, universal, self-sufficient or complete, it can be in the ontological limit. This is a highly complex interdisciplinary and multifaceted problem affecting all aspects of life, which cannot be solved by narrow specialists, experts in a particular disciplinary area of scientific and technical research and investigation.

Ontology describes the properties and characteristics of each object, as well as the interaction between them. Thanks to this, AI understands what actions it can perform with each object and in what situations. Ontologies serve as a basis for explaining the results. This helps to increase trust in the system. They simplify the integration of new concepts and methodologies of artificial intelligence.

Ontology provides standardized terminology and a comprehensive structure covering both technical and ethical aspects of artificial intelligence technologies. Ontologies allow the AI system to make logical conclusions about itself and evolve. This is achieved due to the universality of the way the subject area is represented. Ontology can represent an arbitrary area, including the area of ontological systems itself.

When developing and implementing ontology of artificial intelligence, it is necessary to correlate it with the ontology of natural intelligence, more or less known, and find out how they are related or can be related? What role does ontology play or can it play in artificial consciousness? Isn't ontology the sought-after foundation of any consciousness, including artificial?

Ontology in the general sense is understood as the doctrine of the being. The main questions of ontology are: what is the being, how and why does it exist? Could it not exist? Among the ontologies of natural intelligence, three subject modifications can be distinguished.

For the first subject modification, the key issue is the origin of actual being. The most thought-out and developed are the creationist (being arose from nothing, created in a supernatural act) and substantial (being is indestructible, always was, is and will exist, manifesting itself, one way or another).

The second subject modification is grouped around the dilemma of "one - many". It distinguishes monism and pluralism, a special case of which is dualism. In the era of accelerated development and increasing use of information technologies, the quintessence of which is thought to be AI, another group of ontologies is formed around the principle of objective existence.

In this group, indirect evidence that we are in virtual reality or in the "Matrix" is becoming more and more convincing.

Ontologies for describing the semantics of Web pages

Ontologies of the semantics of Web pages are necessary for search programs to improve the quality of search on the Web. The idea of constructing specifications for conceptualizing the content of Web pages is the basis of the concept of the Smart Web or Semantic Web. The Semantic Web is the next generation of the World Wide Web, which, in addition to hypertext documents, contains descriptions of the semantics of these documents, as well as descriptions of the semantics of various services that provide these documents to end users.

The Semantic Web is usually talked about as a component of the upcoming version of the Web - the so-called Web 3.0. We can only guess what Web 3.0 will actually be like, but it is obvious that one of its main components will be the Semantic Web, in which each Web page also provides ontology of its content.

A formal specification of the content of a Web document enables a search engine to draw conclusions about the correspondence of a search query to a Web document not only based on the syntactic information obtained from the text of this document, but also based on the semantics of the content of this document. This can dramatically improve the quality of Web search, since a description of the world of a Web page that is understandable to a search engine gives the latter much more information than it can get from unstructured text.

The first task that needs to be solved for this is to develop a standard language that would be understandable to all search engines. At present, two such languages have been developed: The Resource Description Framework (RDF) language – a Web resource description system and the Web Ontology Language (OWL) – the Web ontology language. OWL can be considered as an extension of the RDF language.

Description Logic (DL) is based on the formalisms of semantic networks and frames, but uses the apparatus of mathematical logic. In mathematical logic, an

explicit division is made into syntax and semantics. Syntax defines the language by which various statements about the elements of the world of a given logical system are recorded. Semantics defines the part of the described world that satisfies the specified constraints. There can be more than one such part or even an infinite number of such parts. Each such part of the world is called a model of a given logical system.

The language of any description logic consists of a set of unary predicate symbols denoting the names of concepts; a set of binary predicate symbols denoting the names of roles; a recursive definition of terms of concepts, defined using constructors based on concepts and roles.

Concepts denote sets of entities that belong to them. These are classes in programming terminology. Roles define relationships between concepts. Term constructors are operations of first-order logic, such as conjunction, disjunction, universality and existence constraints, and operations that define constraints on the roles of binary relations.

A namespace is a named set of elements and is used to ensure the uniqueness of names for these elements on the Web. Three standard namespaces are used in the Semantic Web.

In mathematical logic, a set is usually used as a model of a logical system. Each element of the set of unary predicate symbols is assigned a unary relation on this set, and each element of the set of binary predicate symbols is assigned a binary relation. Each name of a concept corresponds to a class-subset of the set, and each name of a role corresponds to a binary relation on the set. If some constraints are specified on relations, they must be satisfied on all relations. Each such assignment of a correspondence between names and relations on a set is called a model of this description logic, or its interpretation.

A graph can act as a model. In description logics, a distinction is made between the terminological component – TBox (terminological box) and the assertional component – ABox (assertional box). TBox contains statements concerning

the hierarchy of concepts, i.e. defining relationships between concepts. ABox contains statements characterizing the relationships between individuals and concepts.

In description logic, elements of the TBox set are constraints defined by unary predicates (concepts). This is how they differ from statements of the ABox set. Distinguishing between statements on TBox and ABox is useful when considering the possibility of constructing a logical inference procedure on models of description logics. Statements from TBox define “classification” properties, while statements from ABox define properties that can be conventionally called “instance checking” properties.

Logical inference on these sets can vary significantly in performance, so it makes sense to implement separate inference algorithms for each component. There are many standard types of description logic, defined by various restrictions on the types of relations that can be specified in these types of logic.

Data ontology

A large volume of new information is becoming increasingly difficult to transmit, process, store, despite a significant increase in equipment productivity. But the biggest problem is not the amount of data, but the structuring of the data. Data comes from different sources, in different formats, and at different times. Therefore, before using it in practical tasks, it is organized, transformed, and brought into a form that is efficient for storage and use.

The traditional way of storing and using data is relational databases, in which data is stored in the form of linked tables. However, tabular data is not always efficient to use, so alternative forms have begun to appear, for example, Knowledge Organization Systems (KOS), based on knowledge graphs.

Controlled vocabularies are used to store knowledge. They provide a way to organize knowledge for subsequent retrieval. They are used in subject indexing schemes, subject headings, thesauri, taxonomies, and other knowledge organization systems.

Thesauri group terms into groups according to a certain feature, for example, taking into account similarity (synonyms). Taxonomies contain categorized words, ordered hierarchically. Ontologies formally describe knowledge from a certain subject area domain, taking into account existing complex rules and relationships between elements, allowing for automatic knowledge extraction. Datasets contain sets of machine-readable data.

Knowledge organization systems based on ontologies use different structures. Banks use knowledge graphs to analyze transactions (fraud detection).

Consulting uses graphs based on legal documents.

Healthcare uses accumulated information based on patient health data, Health Electronic Record,

In industry, knowledge graphs are used to analyze supply chains (supply-chain management), in general, Industry 4.0 is characterized by the interaction of cyber-physical systems with each other, which leads to automation and the need to manage knowledge,

In many industries, knowledge bases are used to organize the work of chatbots, including for processing complex queries in natural language.

Information security also has tasks where ontologies are useful. Reducing the attack surface for malicious users by installing patches and updating software never provides 100% protection, since there are vulnerabilities associated with unsafe user behavior, unsafe infrastructure configuration, errors in the settings of implemented security tools, weak passwords, and insufficient control over privileged access. It is very difficult to counteract zero-day attacks, since there are no rules for detecting such attacks in the defending systems; the attack must be recognized and responded to "on the fly".

One way to recognize an attack in the absence of a ready-made recognition template is to use accumulated knowledge and "logical inference" (reasoning) from this knowledge, taking into account the available information about the event. Ontologies that store information about the relationships between various entities can be a way to store such knowledge.

Applied ontologies describe concepts that depend on both the task ontology and the subject area ontology. For knowledge graphs, ontology is a semantic basis for data representation, based on logic and including a terminological dictionary and a set of statements about the objects being modeled. In a simple version, ontology describes only a hierarchy of concepts linked by relationships.

In more complex situations, which are typical for digital production automation tasks, axioms are added to the ontology, describing objects of complex structure and specific relationships between them. Also, ontology is often understood as a specific knowledge base used to solve practical problems.

The purpose of standardizing production ontologies is to solve the problem of information compatibility, formalize production knowledge related to technical data on products throughout their life cycle. Standard models are used to ensure information exchange between the enterprise resource planning system, product data management system, and production process management system. The approach contained in ontology standards is only prescriptive.

It forces users to translate information from general concepts into pragmatic and specific concepts. To ensure interoperability at the enterprise level, it is important that information standards are harmonized, as they contain duplicate and heterogeneous concepts.

InKnowledge

InKnowledge structures knowledge and aims to improve user experience. It is focused on storing and organizing content: articles, news, documents, scripts, reusable fragments (for example, company details) and other types of content, the structure of which the user creates independently. Uploaded files are stored in the internal InKnowledge media library and have a unique identifier. This allows you to replace an image or document in all places where it is used, if necessary.

The knowledge posted in the system is distributed across various subject areas that either intersect or are strictly isolated. The system is designed to integrate

with other systems, bots and virtual assistants in order to act as a single information provider for them.

The structure of the InKnowledge Knowledge Base is in the form of a page tree. Each page is assembled from widgets and can look different depending on the content categories it belongs to. This system implements flexible search capabilities, including full-text, morphological search by word roots, mathematical search using special characters, automatic extension of the search query and search with ignoring typos.

The knowledge base helps to reduce the time spent on searching for information. It provides access to it for clients, partners, own branches and representative offices. With the help of the Knowledge Base, you can set up a self-service portal for clients and close technical support lines without the participation of operators and managers - the company says.

An important part of intelligent data processing solutions is the identification of new knowledge in the form of patterns, implicit relationships and missing data.

If missing data means identifying deviations in a series of normal data, then this is the task of advanced anomaly detection technologies, and it means detecting objects and their groups, events or patterns that differ from the expected patterns. With this approach, models are trained on normal data or events and automatically or based on models with abnormal previous behavior, they allow you to quickly or proactively detect a deviation. Such approaches are used in cybersecurity tasks, to combat fraud and monitor the performance of IT systems.

Technologies of this kind are used in monitoring physical assets and predictive equipment maintenance. The nature of monitoring tasks necessitates the detection of anomalies in near-real time. Therefore, they are implemented using streaming data analysis platforms and in-memory computing.

For the task of identifying implicit connections, the mathematical apparatus of knowledge graphs is actively used. Algorithms and graph analysis are best suited for detecting directions and indirect, non-obvious relationships between various entities and objects of study.

Therefore, graph analysis has become widespread in the cybersecurity market and as a tool for special services and law enforcement agencies, and is also used to analyze social networks.

Such products are united on the market by the term Open Source Intelligence. A framework of the same name is used for research and investigations. OSINT tools allow you to quickly and clearly present all incidents. This enables employees in cooperation with AI to process them quickly and efficiently, for example, quickly stop incidents related to fraud and money laundering.

Solutions are used to build knowledge trees for the purpose of competitive intelligence, development of a mathematical model of ontology and an information system for ontological modeling.

When developing a mathematical model of ontology, the theory of hybrid intelligence systems, set theory, elements of mathematical logic, methods of developing information systems, comparative analysis of information systems and informal analysis of the practical use of the information system are used.

Ontological modeling based on the developed model includes specification, conceptualization and formalization. At the specification stage, a glossary of terms is built. At the conceptualization stage, domain objects and their hierarchy are defined in order to identify the relationship between objects. At the formalization stage, meta-objects and relationships between them are defined, which correspond to objects and relationships between objects. This is the ontology of the domain.

At the stage of its actualization, the parameters of domain objects and their values, classes, subclasses and class instances are defined. Parameters, parameter values, classes, subclasses and class instances are implemented in the ontology in the form of meta-objects of the corresponding types.

The result is an information system with unique hybrid intelligence architecture for automating ontological modeling.

A comparative analysis of the developed information system and the systems used to create ontologies is carried out.

The mathematical model of ontology and the information system for ontological modeling of subject areas are tested during the practical creation of ontology for a specific task. Ontological modeling using an information system reduces labor intensity and speeds up the creation of ontologies.

To master the principles of organizing data in relational databases, you need to know not only normalization forms and relational algebra. It is important to understand the meanings that lie outside the field of programming.

Programs that programmers write are always created for a specific subject area. Thus, accounting software is based on the rules of accounting, and a site for watching TV series is based on such concepts of the television industry.

Understanding the subject area is as important as being able to program. To understand the subject area, you need to identify the key entities around which all the logic is built. Entities do not exist on their own, but are in relationships with each other. Thus, a quiz aggregates questions that have answers. A profession consists of courses, and courses consist of lessons. Lessons consist of theory, a quiz, and practice. These connections have specific names.

A description of objects in the area under consideration and the connections between them is called the ontology of the subject area. Programmers, business analysts, and managers communicate with customers, who can themselves act as experts. Together with them, they build a formal ontology and identify specific terms. They agree on what they mean and how they are related to each other.

Using an ER model, a programmer creates the necessary data model. Not necessarily on paper or in specialized programs. Such a model exists only in the head and code. This model becomes the basis for database design. Each entity in a relational database is represented by a table. Relationships between entities are implemented through foreign keys.

Ontologies and knowledge graphs for smart manufacturing

Corporations are investing heavily in creating knowledge-driven applications that act as an intelligent knowledge factory that continuously generates new

knowledge by continuously analyzing multiple disparate data sources within the company. The core of such solutions are knowledge graphs, which include graph repositories of semantic metadata or knowledge formalized using special formal semantic languages and ontologies that act as a semi-structured conceptual scheme of the subject area.

Knowledge graphs help solve difficult-to-formalize intellectual problems, shifting the focus from data storage to linking, reusing, and coherent circulation of data. This allows the company's data to be transformed into active knowledge by using modern machine learning methods specialized for graph models of data representation.

For knowledge graphs, ontology is the semantic basis for data representation. It is based on logic and includes a terminological dictionary and a set of statements about the objects being modeled. Ontology is understood as a specific knowledge base used to solve practical problems.

Standard ontologies for digital manufacturing have been developed. The Process Specification Language provides an ontological format designed to automatically exchange process information between various manufacturing applications, such as production modeling and planning, workflow, document management, project management, and business process reengineering tools.

Logical terms are defined in an ontology that provides a formal description of the components and their relationships that make up a process. In the manufacturing domain, an ontology is a common representation for integrating multiple process-related applications throughout the life cycle of a manufacturing process. The ontology uses the Common Logic Interchange Format (CLIF) to represent concepts, constants, functions, and relationships.

Interoperability is achieved by translating between the native ontology format and the PSL. The ontology is designed to facilitate the integration of business and manufacturing applications within an enterprise. It describes the properties of various objects in a manufacturing information model. The purpose of an ontology is to provide a consistent terminology that is the basis for communication between

suppliers and manufacturers, to provide consistent information models and models of operation that serve as the basis for explaining the functionality of applications and how information is used.

An ontology is intended to harmonize intelligent agents using different terminology. It is not universal, standard, or general. It is used to create a model that helps in comparing entities with other ontologies and revealing hidden assumptions underlying existing ontologies and linguistic resources.

The basis of an ontology is the division of entities into universals (entities that potentially or actually have instances) and individuals that do not have and cannot have instances. An example of a universal is the concept of a "part", since it has many instances, specific examples in the surrounding world. The concept of "time" is considered as an individual.

An ontology introduces a division into constant and occurring entities. Constant entities are unchangeable in some fixed period of time, for example, a machine during its correct operation. Occurring entities at any moment of some time interval may be different or have different composition, for example, a drill changing its properties of sharpness, temperature.

The ontology is used for autonomous production management. Its architecture is based on a set of holons, each of which represents a digital image of a production component of a physical resource (numerical control machines and robots) or a logical entity (orders). A holon is understood as some entity that is whole in itself and part of something else. The general holon contains a logical control device (LCD) and a physical resource capable of performing production tasks.

Each available product is represented by a product holon, responsible for short-term process planning. Each production order launched in the workshop for the production of a product is represented by a task holon, contains dynamic information about the production order. Operational holons represent physical resources such as operators, robots, and software-controlled machines.

A formal domain ontology is developed to represent manufacturing service capabilities for automatic supplier discovery in distributed environments with a fo-

cus on machining services. The ontology represents manufacturing at five abstraction levels: suppliers, shops, machine tools, components, and processes.

The ontology is built on a service-oriented paradigm platform. It is used to build time-based supply chains. It is developed for automatic supplier discovery in distributed environments with a focus on machining services. It is an axiomatic ontology of the manufacturing domain.

It includes architecture and tools for automatic cost estimation of manufacturing. Supplier companies compete based on price, superior technical expertise, delivery time, and reliability in accordance with established deadlines. Versatility of manufacturing is essential in a constantly competitive environment.

In the ontology, the most important concepts are geometric objects for manufacturing, which represent abstract and concrete spatial objects (e.g. a production building), raw materials, considered as abstract entities of parts, and cost objects, which represent basic descriptions of production costs. In the Cloud-based Rapid Elastic MANufacturing (CREMA) process ontology model, manufacturing tasks are described in a standard business process modeling notation.

They correspond to the semantic service-oriented architecture. The modular approach to software development is based on the use of distributed, loosely coupled replaceable components equipped with standardized interfaces for interaction via standardized protocols. The components perform optimal service implementation of the specified process models using semantic annotation of both process models and available services.

Annotation of process models is performed manually by a manager using specialized interfaces. In a similar way, resources can be allocated to a suitable robot manipulator. Given a production schedule containing a list of orders, the system determines the appropriate robot and rents it to perform the tasks included in the schedule.

The ontology is based on syntactic analysis, which allows comparing formalized knowledge using technical production data. This knowledge is described using various standards and is intended to solve the problem of managing hetero-

geneous information. They are related to product data management at the business level and at the production level.

The standard describes product information, including geometry, technical drawings, project plans, part design files, assembly diagrams, specifications, CNC machine programs, analysis results, correspondence, and specifications and change orders. The ontology defines a set of reference models for information exchange between business and production management applications and is an interface between production planning, operations management, and shop floor coordination.

The ontology is used to ensure semantic interchangeability and generate new knowledge in the context of decision making during product maintenance. In addition to the glossary and its classification in the form of a hierarchical tree, the ontology includes domain concepts and relationships between them. The goal of this approach is to obtain a rich ontology with various types of relationships.

Open knowledge graphs

The most valuable and effective are knowledge graphs developed specifically for individual production tasks and subject areas. Such systems are not public and represent a commercial secret. At the same time, there are many examples of general-purpose knowledge graphs available on the Internet.

The basics and concept of user-friendly knowledge graphs were first implemented in 2007 in the DBpedia knowledge base, created by semantically processing Wikipedia article infoboxes. DBpedia added a detailed data schema (ontology), geographic data, and links to other graphs.

DBpedia is currently considered one of the knowledge graph standards and contains over 6 billion linked facts. In 2008, the YAGO graph was developed. Its distinctive feature is the use of the WordNet semantic thesaurus and a very detailed hierarchy of entity classes. YAGO currently contains about 120 million facts. In 2010, the Never-Ending Language Learner (NELL) system was launched. It "reads" web pages and automatically navigates between them, trying to extract

facts from the text of web pages into a knowledge graph. NELL contains about 50 million facts, including 2 million facts that NELL is completely confident in.

The Freebase knowledge graph takes a different approach to modeling facts than the previous three graphs. Instead of using pre-built data schemas (ontologies), Freebase allows users to assign a category to the entity they are describing. This is more like a tag cloud than a class tree. In 2014, Freebase contained about 2 billion facts and was acquired by Google, and then transformed into the Google Knowledge Graph, which provides uniform knowledge to all of the company's services, from search and mail to voice assistants.

The Wikidata graph is designed to store knowledge that will be used in Wikipedia, most often in the form of filling in infoboxes and tables on the page in many available languages. Wikidata uses an advanced approach to knowledge modeling, allowing for more detailed descriptions of entities and relationships. Wikidata contains about 7 billion facts about more than 50 million entities.

Most published knowledge graphs use the Wikidata model or link their entities to existing entities in Wikidata. The knowledge graphs available on the Internet form the Linked Open Data Cloud (LOD Cloud), semantically combining published graphs into one giant network. The cloud has grown to 1,234 graphs in nine different domains.

Machine learning for solving information retrieval problems

Ontologies and knowledge graphs can not only combine various data sources into a common repository, but also solve the problem of information interoperability and formalization of production knowledge.

Knowledge is a dynamic structure with its own life cycle, which requires constant modification and updating of data in knowledge graphs. Such modification uses a set of machine learning methods and refers to the tasks of Information Extraction. These tasks include Named Entity Recognition/Extraction distinguishing between the positions of entity mentions in the input text; Entity Linking/Disambiguation, Semantic Annotation associating entity mentions with a suit-

able and unambiguous identifier in the knowledge base; Term Extraction – extracting the main phrases that denote concepts relevant to the selected subject area and described in the corpus, sometimes including hierarchical relationships between concepts; Keyword/Keyphrase Extraction.

They allow categorizing the subject matter of the text. Unlike term extraction, keyphrase extraction is about describing the text itself, not the subject area. Keyphrases can also be associated with a knowledge base.

Topic Modeling and Classification implements the function of clustering words and phrases that often occur together in similar contexts. These clusters are then associated with more abstract topics that the text is related to.

Topic Labeling/Identification is used for clusters of words identified as abstract topics, extracting a single term that best characterizes these topics. Relation Extraction involves extracting potential n-ary relationships from unstructured or semi-structured sources.

Typical tasks of analyzing production information

Building digital twins allows you to integrate a variety of information about the company's equipment and infrastructure in the form of a virtual copy of real objects. Joint analysis of dynamic sensor readings and data on the design of objects helps reduce the time it takes to make management decisions. Combining information about financial, legal and other parameters of the company's work in knowledge graphs allows for more efficient identification of risks and possible conflicts of interest when planning and monitoring production situations.

Numerous production and technological processes at an enterprise are associated with receiving and analyzing data from various sensors and information systems. Such information is usually presented at different levels of abstraction and data detailing, and work with it is carried out by different departments and specialists. Combining these levels in a common knowledge graph allows for comprehensive observation and monitoring of processes, combining different points of view and contexts.

Modern equipment is equipped with hundreds of thousands, and sometimes millions, of sensors and various digital devices that collect data on functioning and operating modes. Together, these data can be used to improve management efficiency. Knowledge graphs allow for combining technical documentation, regulations and equipment specifications with operational data, which simplifies decision-making on the technical condition of the equipment and the need for its maintenance or repair.

To solve these problems, it is necessary to automate the process of constructing knowledge graphs. Such automation implies the inclusion of ontological methods and machine learning in the general cycle of information processing.

The former is necessary for annotating data, performing logical inference and semantic search in cases where the data clearly contains a description of production objects and processes. But if the data is incomplete, very noisy or contains implicitly expressed knowledge, then it is more effective to apply machine learning methods and vector representations.

In its most general form, the process of automated construction of knowledge graphs includes operations of presenting data from a certain source of information in the form of triples <subject, predicate, object>; annotation, linking and enrichment of data using ontologies of the subject area. It ensures improved data quality using machine learning and statistics methods in the tasks of extracting named entities and relationships, defining a topic.

It is associated with the assembly of a knowledge graph from the obtained triples using ontologies. Each of the operations requires the execution of intermediate actions using artificial intelligence technologies. 31. Automatic Ontology Generation for Knowledge Graphs

AI technologies extract knowledge directly from existing structured and unstructured text sources of production data using various intelligent algorithms, including machine learning methods and neural networks. The role of the expert is to design conceptual high-level abstractions of ontologies.

Automatic construction of ontologies for knowledge graphs

AI technologies extract knowledge directly from existing structured and unstructured text sources of production data using various intelligent algorithms, including machine learning methods and neural networks. The role of the expert is to design conceptual high-level abstractions of ontologies, provide reliable ways to access data, mark up data for using AI methods, and validate the results. The automated approach is called ontology learning.

Ontology training is carried out on the basis of semi-structured data as a certain sequence of coordinated actions for extracting from data and assembling individual ontology elements.

The first step is to extract the main terms from the text. Then, using the definition of synonyms, the set of terms is transformed into a set of concepts. They are structured to form a hierarchy of concepts. Interrelations between concepts are identified, and a hierarchy of connections is determined. An axiom scheme and general axioms of the ontology are formed. Vector representations and machine learning for industrial knowledge graphs

One of the fundamental problems in the practical use of knowledge graphs is the exponential growth of their complexity when adding new knowledge, which is manifested in an increase in the number of connections between graph nodes. But the knowledge graph may often be insufficiently informative for particular situations, which may again require its supplementation. To solve such problems and effectively work with large knowledge graphs, vector representation models (embeddings) have been developed. These models have been effectively applied to the task of searching for text information.

Y. Bengio proposed a neural model for the vector representation of words, which calculated the probability distribution of finding a particular word depending on another word, and extracted a vector of latent features for each word in the dictionary. These properties are called latent properties, since they are not directly described in the data, but can be inferred from the available data in the process of machine learning. Since an important property of graph data is the possibility of

various correlations between many interconnected nodes, it becomes possible to use the apparatus of vector representations for the task of information retrieval. Such correlations can be calculated by including the processing of attributes, relationships, and classes of related entities in the machine learning algorithm.

The difficulties and barriers to the digital economy and intelligent production are not related to the lack of digital services and data, but to the diversity of information platforms and data formats. Traditional approaches do not offer ways to overcome these barriers, but only worsen the situation when implementing another information system or standards.

The tasks of exchanging data between such systems are implemented by the efforts of analysts and data engineers of companies. To solve these problems, it is necessary to ensure the automated integration of heterogeneous data sources into a single information field, which should be based on formalized knowledge.

An approach called "industrial knowledge graphs" has been developed. It allowed not only to automate complex processes of data integration and analysis, but also to generate new knowledge, revealing the potential of implicit connections between disparate parts of the enterprise's information infrastructure. The creation of industrial automated solutions based on semantic technologies, controlled by formalized knowledge, is a step towards the sixth technological paradigm.

Information ontology

The ontological approach to information assumes consequences that can be obtained from solving the problem of being. Different solutions correspond to different consequences. The meaning of information as a concept is the certainty of what this information is about. At the same time, any certainty is the result of comparison. The act of distinction brings the act of distinction closer to the binary nature of computer operation.

Distinction is the essence of information. This position is substantiated by relative ontology, the essence of the main position of which is in an extremely brief thesis: to be means to differ. Distinction is the distinction between one and another.

In order to correctly understand the positions and conclusions of relative ontology, it is necessary to keep in mind the limitations of modern language, which mainly records a separate entity. Thus, the main parts of speech of almost all languages of the world are the noun, adjective and verb.

The noun records the entity in itself, that is, without taking into account the other. An adjective fixes the definiteness of a noun, that is, of an entity, and this definiteness is also presented as something independent and self-sufficient.

A verb fixes the process of change (or lack thereof) of an entity, and, as a rule, this change (or its absence) of the being, and, as a rule, this change (absence) is indicated as unrelated. Therefore, there may be difficulties in fixing and expressing the act of coexistence. This circumstance causes some grammatical paradoxes of relative ontology.

The uniqueness of the solution to the problem of being by relative ontology is that this solution can be presented through the subtraction procedure. Distinction means something other than the fact that one has something that the other does not have. But this is exactly what is meant in the subtraction procedure, of course, only in the case when the result of the subtraction is different from zero. Along with this, it is necessary to take into account the position of formal logic that the comparison will be correct if the property by which it is realized is specified. In relative ontology, such a property is called an attribute.

The formalism of subtraction allows us to quantitatively express the meaning of information. Under the condition of finiteness of attribute values, that is, under the condition of limitedness of the members of the selected set, the understanding of the meaning will be extremely accurate.

The described procedure can also be presented in terms of formal logic, where the most effective way to define the meaning of a concept is a genus-species definition. In our case, the genus of the concept being defined is nothing more than an attribute, and the species expresses the value of the attribute.

However, unlike formal logic, in order to understand the meaning of the specified species, it is necessary to construct an ordered series of the remaining

species of this genus, and then the place in this series is the meaning of the corresponding species.

A numerical series is nothing more than a mathematical expression for an ordered series of word meanings, that is, a number is always a quantitative expression of the meaning of a word or text. Consequently, a word and a number have the same ontological basis. This conclusion is valid only in the case of a finite set of entities that differ in the same attribute.

This is what opens up opportunities for a computer to operate with meanings and values of information. In the case when entities have several attributes, a similar procedure must be carried out for each attribute.

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